Environmental Assessment for Cosecha:

A Rainwater Harvesting Project in Southern Honduras

December 30, 2015

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Cover photo: A pilot site for small-scale reservoirs in Moracito, Nacaome, Honduras. Credit: [redacted] (Cadmus)

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LIST OF ACRONYMS

BEO	Bureau Environmental Officer
CAAM	Central American Atlantic Moist Forests
CAMF	Central American Montane Forests
CAPD	Central American Pacific Dry Forests
CAPO	Central American Pine-Oak Forests
CFR	Code of Federal Regulations
CIAT	International Center for Tropical Agriculture
CIIU	International Uniform Industrial Classification
DIV	Development Innovation Ventures
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EOS	Earth Observing System
FAO	Food and Agriculture Organization (of the United Nations)
FOSDEH	Foro Social de la Deuda Externa de Honduras y Desarollo
GC	Global Communities (formerly CHF International)
GDP	Gross domestic product
GHFSI	Global Hunger and Food Security Initiative
GIS	Geographic information system
HDI	Human Development Index
HTH	Calcium hypochlorite
INE	National Institute of Statistics
IPCC	Intergovernmental Panel on Climate Change
MFI	Microfinance institutions
MoA	Honduras Ministry of Agriculture
MPF	Mosquitia (Meskito) Pine Forests
masl	Meters above sea level
NGO	Non-governmental organization
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
RCT	Randomized control trial
ROI	Return on Investment
SERNA	Secretaría de Energía, Recursos Naturales, Ambiente, y Minas
SINEIA	National System for Environmental Impact Evaluation Agreement
TOR	Terms of Reference
UNDP	United Nations Development Program
USAID	United States Agency for International Development
USAID/GDL	USAID Global Development Lab
USG	United States Government

EXECUTIVE SUMMARY

This Environmental Assessment (EA) was prepared as part of the U.S. Agency for International Development (USAID) environmental compliance process for *Cosecha: A Rainwater Harvest Project in Southern Region of Honduras*. The intent of *Cosecha* is to evaluate rainwater harvesting for irrigation and the impact of the technology on agricultural production and human nutrition. The project will evaluate the effectiveness of rainwater harvesting technology at 10 candidate sites (Table 1). If the project provides compelling evidence that the rainwater harvest and drip irrigation systems help the target population of Honduran farmers achieve higher agricultural productivity, then the design approach and technology used at the 10 sites could provide information on best practices for designing rainwater harvesting projects within the country and region.

The project is an activity of Global Communities (GC), the Honduras Ministry of Agriculture (MoA), the International Center for Tropical Agriculture (CIAT), and two Honduran partners, with partial funding from the USAID Global Development Lab (USAID/GDL). This EA builds upon issues identified in a Scoping Statement prepared for *Cosecha* and approved by the GDL Bureau Environmental Officer (BEO) in October 2015; both documents comply with USAID's Environmental Procedures.

The October 2015 Scoping Statement identified the potentially significant impacts to be evaluated further in this EA, and it provided justification for eliminating non-significant impacts from the scope of the EA. The Government of Honduras has plans separate from this project to develop rainwater harvesting technology to be scaled-up and implemented country-wide. Thus, it is important to note that this analysis is limited to the 10 candidate sites of the Proposed Action. Although the impacts likely to result from scaling-up are indicative of issues with rainwater harvesting in general, the 10 sites reviewed in this EA are not necessarily representative of conditions country-wide. This EA will further evaluate the issues identified in the Scoping Statement and evaluate alternatives, compare impacts, and propose mitigation measures that address the potential impacts.

Table 1. Ten Candidate Sites Evaluated in the Scoping Statement

DEPARTMENT	MUNICIPALITY	COMMUNITY
Choluteca	Namasigue	La Constancia 1
Choluteca	Namasigue	San Rafael 2
Choluteca	Namasigue	Las Pilitas 2
Choluteca	Namasigue	Vuelta al Cerro 1
Choluteca	El Triunfo	Altos de Doña Julia
Choluteca	Namasigue	Santa Irene 1
Valle	Nacaome	Altos El Estiquirin 2
Valle	Nacaome	El Tamarindo 2
Valle	Nacaome	Chaguite
Choluteca	Namasigue	Vuelta al Cerro 2

[1] The Scoping and EA teams were unable to visit Vuelta al Cerro 2 because the site was added after the field visit in August 2015.

Each of the proposed sites will use communal reservoirs linked to gravity-fed, ultra-low drip irrigation systems in combination with improved agronomic practices and technical assistance to grow both subsistence and higher-value horticultural crops. In addition to the sites listed above, the Scoping Team also visited one example site with a reservoir, Moracito in Nacaome, Valle, a Global Communities project. The Scoping Team observed the infrastructure required for rainwater harvesting and interviewed the project beneficiaries regarding the operation, management, and early benefits of the project. The beneficiaries indicated that the water provided by the reservoir allowed them to cultivate watermelon as a cash crop, whereas previously they were not able to cultivate crops other than subsistence crops such as rice and beans.

The Scoping Statement identified the following aspects of the project with potential significant adverse impacts that are evaluated in this EA:

1. Maintenance of environmental flow (water) in the stream channels below the reservoirs;
2. Factors related to construction and design of the reservoirs for long-term sustainability, including: assessment of soil type; patterns of precipitation, including long-term patterns influenced by climate change; water volume; slope; evapotranspiration potential, specifically the surface-area-to-volume ratio; and the condition of the watershed;
3. Plans for management of cattle and/or other livestock near the reservoir sites, including exclusion of livestock and provision of other water sources for the livestock;
4. Technical assistance for the following:
    a. Planning and implementation of reforestation in the reservoir watersheds (including cultivating saplings, species selection, planting, maintenance, etc.)
    b. Aquaculture techniques in the reservoirs where project implementers plan to introduce tilapia to control mosquitos;
5. Community outreach and training to reduce and mitigate unintended and unsustainable impacts on wildlife, including unsustainable levels of hunting, because wildlife might be attracted to the reservoirs as a water source;
6. Micro-watershed management for long-term sustainability of the water source and reservoir; and
7. Community management of the reservoirs, especially adding new beneficiaries to the producer groups.

From stakeholder consultations, field visits, and document reviews, the Scoping Statement described eight additional concerns (listed below) that can be eliminated from detailed study in the EA. Section 6 of the Scoping Statement discusses these concerns and provides justification for eliminating them:

1. Construction-related noise impacts;
2. Impacts on air quality;
3. Loss of habitat for native plants and animals within the area that will be inundated at each reservoir site;
4. Contamination of the reservoirs by agro-chemicals;
5. Impacts on vegetation within the area that will be inundated at each reservoir site;
6. Impacts related to poor management of solid and liquid waste and excrements;
7. Closing and abandonment of the project;
8. Construction-related access to reservoir sites.

This EA follows the format required by USAID in 22 CFR 216.6. The project has already received approval from the MoA and other relevant agencies. Thus, the purpose of this EA is to fulfill the environmental compliance requirements of 22 CFR 216. The EA evaluates the proposed action, the no-action alternative, and two other alternatives relative to the affected environment, potential impacts, and environmental consequences.

1.0 SUMMARY

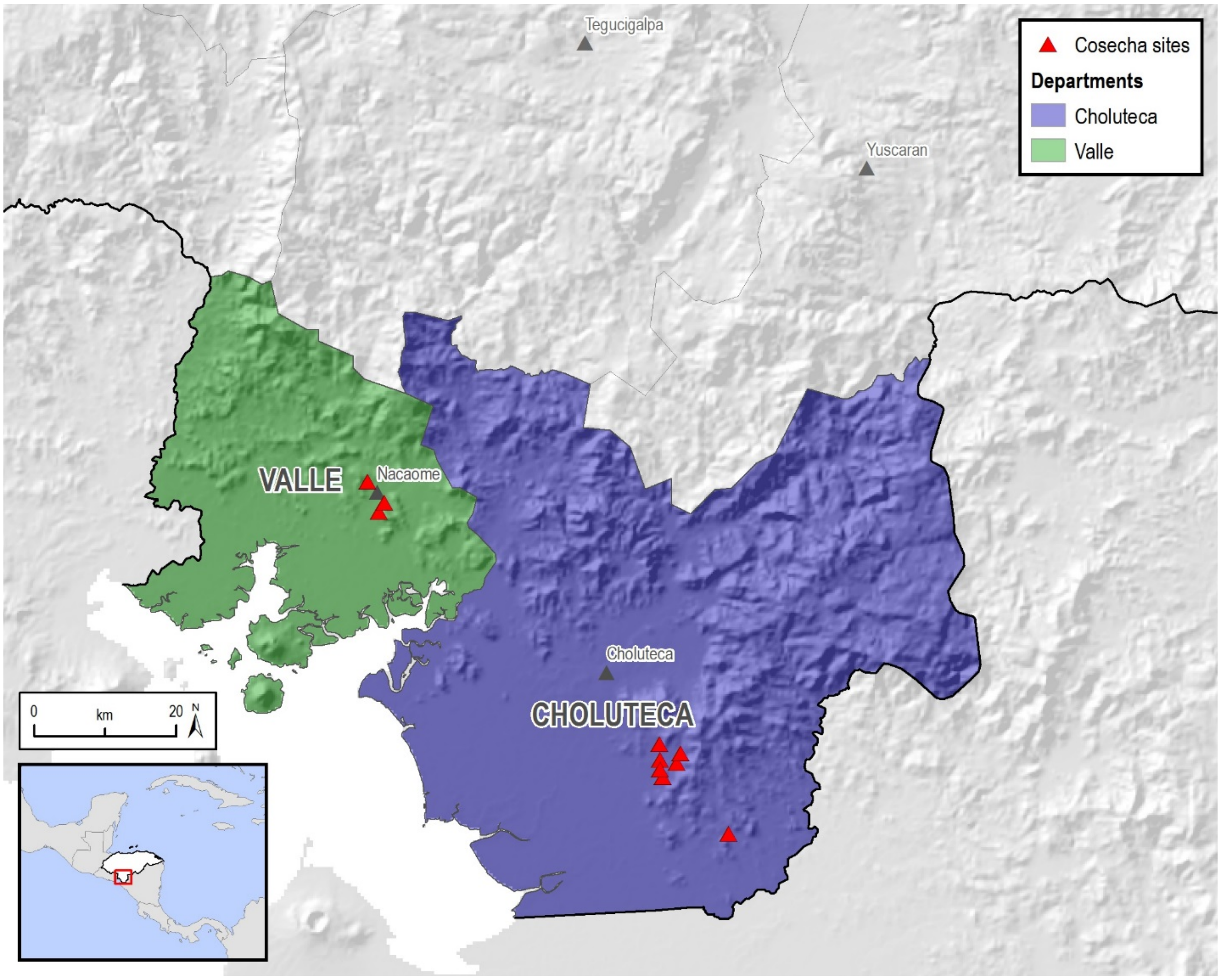
This EA evaluates the proposed action and reasonable alternatives against the potentially significant impacts identified in the Scoping Statement for *Cosecha: A Rainwater Harvesting Project in Southern Honduras*. Specifically, it evaluates the proposed action, the no-action alternative, and two additional alternatives – development of groundwater wells for irrigation, and construction of reservoirs but using sprinklers for irrigation rather than ultra-low drip irrigation. Issues of concern include the following:

- Maintenance of environmental flow (water) downstream of the reservoirs to maintain ecosystem function;
- Management of wildlife and livestock that are attracted to the reservoir as a water source;
- Lack of systemic hydrological data makes prediction of both social and environmental impacts challenging;
- Watersheds already are largely impacted; although reforestation efforts are planned, specific training and capacity building is needed to ensure restoration of forest function;
- Structural integrity of the earthen dams;
- Potential for the micro-reservoirs to become a source of disease if mosquitoes are not properly managed.

This EA analyzes the proposed construction of 10 small rainwater-fed reservoirs in Southern Honduras in the Valle and Choluteca regional departments (Figure 1). These departments are considered particularly vulnerable to both drought and flooding, which disproportionately affects those with few economic resources, such as smallholder farmers. Although other alternatives are evaluated in this EA, the proposed action would most effectively fulfill the project's purpose to test the impact of rainwater harvesting on agricultural production as a means to enhance community-level resiliency to drought and other climate variability in Southern Honduras, and to demonstrate the feasibility for larger-scale implementation. It would also fulfill the need to improve agricultural production and food security, decrease malnutrition, and enhance the region's resilience to the impacts of climate change by harvesting rainwater for use in drier periods of the year.

Greater yields, increased productivity per unit of input, reduced risk, and increased market access all depend on a capital investment to enhance resiliency to drought and other climate variability. The No Action Alternative forgoes the construction of the proposed diversion and irrigation schemes, while the groundwater alternative is comparable in cost but would generate benefits for fewer farmers. In a region with high evaporation potential and a possible 10-20 percent decrease in precipitation by 2050, the use of sprinklers combined with reservoirs would not represent the most efficient use of water. Absent finance to invest in infrastructure, farmers will remain exceedingly vulnerable to droughts, unpredictable rainfall, and climate change. They will also remain vulnerable to food shortages and will be limited to crop production in the rainy season only, further challenging food security and exacerbating poverty rates.

Figure 1. Valle and Choluteca Departments in Southern Honduras



1.1 ENVIRONMENTAL ASSESSMENT METHODOLOGY

The Scoping Phase for this EA was conducted between November 2014 and August 2015. The November/December consultation phase was led by Global Communities, and the August 2015 consultations also involved a two-person consultant team that visited the proposed sites and communities in Honduras. During the August 2015 scoping visit, the Global Development Lab BEO also accompanied the scoping team. In November and December 2014, Global Communities organized 11 community forums to generate awareness about the project. During the project design phase, the Global Communities team also consulted with affected residents, civil society groups, local leaders, and relevant private and public sector providers to identify significant issues and to gather local information related to the project. The regional public authorities, local and municipal sectors of organized civil society, and the private sector that were consulted include the Ministry of Natural Resources (Mi Ambiente, formerly SERNA), Ministry of Agriculture and Livestock (SAG), Ministry of Public Health (SSP), Ministry of Education (SE), Forest Conservation Institute (ICF), Foundation Agrolibano (FA), Municipal City Hall/Municipal Environmental Unit (UMA), Community Boards (PC), Water Management Boards (JAA), Rural Savings and Credit (CRAC), and Technical Community Health (TSC).

Prior to the August 2015 site visit, the Scoping Team reviewed relevant documents and collected information about Southern Honduras. During the August 2015 visit, the scoping team, accompanied by Global Communities staff, visited one demonstration reservoir site constructed by Global Communities and nine of

10 proposed sites for the current phase of the project. The Scoping Team consulted with community members and landowners at each of the sites to further understand the potential benefits and concerns of the community members. Additionally, the team collected baseline information at each site. The Global Development Lab BEO approved the Scoping Statement on October 22, 2015, and preparation for the EA began approximately one week later.

Due to budget constraints, the consulting firms that prepared this EA—Cadmus Group International and Sun Mountain International—conducted the EA primarily as a desk-based analysis. The August 2015 scoping visit was undertaken to inform both the scoping phase and the EA phase. A Honduras-based consultant also conducted a limited amount of additional in-country research and consultations for the EA.

The EA Team consisted of:

- [redacted] (Impact assessment specialist and team leader)
- [redacted] (Agro-forestry and climate change specialist)
- [redacted] (Honduras-based environmental expert)
- [redacted] (QA/QC review)

DATA COLLECTION & RELEVANT LITERATURE REVIEW

The EA Team reviewed literature gathered during the scoping phase and during the initial phases of the EA. In particular, during the EA phase, the Team concentrated on obtaining the most recent and reliable irrigation scheme descriptions and updated information on precipitation, land use, and wildlife presence in the region.

The References section of the EA contains a full list of reports gathered by the Scoping Team and the EA Team. Many of these documents contain information that will be useful to USAID/Honduras, USAID/Global Development Lab, the Government of Honduras (GoH), and implementing partners as these groups implement projects to improve agricultural production in Honduras via small-scale reservoirs. In addition, the maps developed by The Cadmus Group are available to USAID as part of this EA.

MAPPING /GEOSPATIAL ANALYSIS

Cadmus' US-based offices provided the GIS support for this EA. Specifically, the mapping effort focused on locating updated geospatial data for roads, watersheds, land use, protected areas, precipitation, ecological zones, and livelihoods. The result is a map portfolio focused on the southern departments of Valle and Choluteca.

The following maps were created for this EA:

- Villa and Choluteca Departments in Southern Honduras
- Watersheds in Valle and Choluteca
- Livelihood Zones in Southern Honduras
- Elevation of Valle and Choluteca
- Average annual precipitation in Valle and Choluteca
- World Wildlife Fund Ecoregions in Valle and Choluteca
- Land Use in Southern Honduras (2001 and 2012)
- Land Use Change (2001 to 2012)
- Protected Areas in Southern Honduras

STAKEHOLDER CONSULTATIONS

During the scoping phase, the Scoping Team consulted stakeholders in small-group discussions and interviews and in large, focused community discussions. In the Scoping Statement, the Scoping Team responded to key points raised during scoping, and the Team used consultation findings to identify potentially significant impacts to be evaluated in this EA.

Affected residents, civil society groups, local leaders, and relevant private and public sector providers have been involved in a series of discussions and interviews to assist in identifying significant issues and to gather local information related to the project. The regional public authorities, local and municipal sectors of organized civil society, and the private sector groups that were consulted include the Ministry of Natural Resources (Mi Ambiente, formerly SERNA), Ministry of Agriculture and Livestock (SAG), Ministry of Public Health (SSP), Ministry of Education (SE), Forest Conservation Institute (ICF), Foundation Agrolibano (FA), Municipal City Hall/Municipal Environmental Unit (UMA), Community Boards (PC), Water Management Boards (JAA), Rural Savings and Credit (CRAC), and Technical Community Health (TSC).

In late 2014, Global Communities organized 11 community forums (Table 2) to generate awareness and receive feedback on the current state of water resources, agriculture, and the proposed project in the first phase of the scoping process. In August 2015, the Scoping Team visited nine communities (Table 3).

Table 2 Community Forums Conducted in 2014

DEPARTMENT	COMMUNITY	MUNICIPALITY	DATE
Choluteca	La Constancia	Namasigue	1 December 2014
Namasigue	El Tajo	Namasigue	20 November 2014
Choluteca	La Danta	Namasigue	3 December 2014
Choluteca	La Vuelta del Cerro	Namasigue	3 November 2014
Choluteca	San Agustin	Namasigue	2 December 2014
Choluteca	San Francisco	Namasigue	27 November 2014
Choluteca	San Rafael Centro	Namasigue	3 December 2014
Choluteca	La Laurelada	El Corpus	2 December 2014
Choluteca	Guanacaste Abajo	Concepcion de Maria	1 December 2014
Choluteca	El Tamarindo	Apacilagua	18 November 2014
Valle	Altos del Estiquirin	Nacaome	2 December 2014

Table 3 Communities Visited During the August 2015 Scoping Statement Field Visit

DEPARTMENT	COMMUNITY	MUNICIPALITY	DATE
Choluteca	La Constancia	Namasigue	15 August 2015
Choluteca	San Rafael 2	Namasigue	15 August 2015
Choluteca	Las Pilitas 2	Namasigue	16 August 2015
Choluteca	Vuelta al Cerro 2	Namasigue	16 August 2015
Choluteca	Altos de Dona Julia	Namasigue	17 August 2015
Choluteca	Santa Irene 1	Namasigue	17 August 2015
Valle	Altos de Estiquirin 2	Namasigue	18 August 2015

Valle	El Tamarindo 2	Nacaome	18 August 2015
Valle	Chaguite	Nacaome	18 August 2015

[1] A tenth site, El Tamarindo 3, originally was scheduled, but the owner decided against participating while the Scoping Team was in the field.

The Scoping Team identified information gaps to be filled during the EA phase via additional consultations with the implementing partner, government entities, and other stakeholders and desk-based research. Given the limited capacity for additional in-country consultations, the EA team focused efforts on filling key specific information gaps rather than performing broad-based consultations. One Honduras-based EA team member collected additional information on rainwater harvesting practices as well as hydrological, ecological, and socio-cultural data.

2.0 PURPOSE OF THE EA

As required in 22 CFR 216.6(c) (2), this section briefly specifies the underlying purpose and need to which USAID is responding in proposing the alternatives, including the proposed action. For purposes of background, this section includes a brief description of related activities of USAID/Honduras in their Development Objective (DO) 2: Economic Growth Program. Additionally, Section 2.1 (below) includes a description of USAID/Global Development Lab (GDL) structure and how GDL tiers its investments.

In the USAID/Honduras Country Development Cooperation Strategy (CDCS) for 2015–2019, USAID/Honduras identified two DOs to meet the stated goal of a "more prosperous and safer Honduras that advances inclusive social and economic development among vulnerable populations."

The two DOs are:

1. DO1: Citizen Security Increased For Vulnerable Populations In Urban, High-Crime Areas
2. DO2: Extreme Poverty Sustainably Reduced For Vulnerable Populations In Western Honduras

The USAID/Honduras-approved CDCS implements USAID programs to strengthen the participation of marginalized groups in local and national governance; increase food security for the poorest sectors of society; support renewable energy and environmental conservation; and improve decentralized health care in terms of quality and access for local citizens and civil society. USAID projects work to spur economic growth, advance social justice, improve education and health, and engage the poorest members of Honduran society in the country's development. USAID/Honduras efforts, through DO1, also address citizen security through community-based crime prevention activities and seeks to expand basic education and skills training for at-risk youth and adults.

DO2 was developed based on the hypothesis that if natural resources and biodiversity are protected and enhanced, resilience of livelihoods to climatic and economic shocks is strengthened (IR 2.1), families are able to increase their incomes (IR 2.2), and human capital is improved by focusing on improving education and health for these communities (IR 2.3), resulting in a sustainable reduction of poverty in Western Honduras.

Thus, DO2 activities operate through Intermediate Results (IRs) and are designed so that poor families will acquire tools to sustainably increase household incomes through improved resource management and human capacity.

DO2 activities will mainly occur in Western Honduras, while the Cosecha project sites are located in Southern Honduras. Rainwater harvesting is being considered as a potential activity under DO2; therefore, the lessons learned from the Cosecha project may provide valuable information in the design of future rainwater harvesting projects.

2.1 USAID/GLOBAL DEVELOPMENT LAB

USAID's Global Development Lab (USAID/GDL) is a new bureau within USAID that seeks to increase the application of science, technology, innovation, and partnerships to extend the Agency's development impact in helping to end extreme poverty.

USAID/GDL aims to:

- Produce breakthrough development innovations by sourcing, testing, and scaling proven solutions to reach hundreds of millions of people.
- Accelerate the transformation of the development enterprise by opening development to people everywhere with good ideas, promoting new and deepening existing partnerships, bringing data and evidence to bear, and harnessing scientific and technological advances.

USAID/GDL's Center for Development Innovation develops new breakthroughs by supporting the discovery, incubation, and testing of solutions to specific problem areas, using open platforms for innovation. The Development Innovation Ventures (DIV) team was launched in 2010; it is a GDL grant-making program to find, test, and scale ideas that could radically improve global prosperity. DIV is part of the Lab's Center for Development Innovation.

DIV holds a year-round grant competition for innovative ideas, pilots and tests them using cutting-edge analytical methods, and scales solutions that demonstrate widespread impact and cost-effectiveness. DIV's tiered-funding model, inspired by the venture capital experience, invests comparatively small amounts in relatively unproven concepts and continues to support only those that prove they work. The approach consists of a three-tiered staged finance model to maximize cost-effectiveness and minimize the risk of testing new ideas. Applicants can apply at any stage:

- **Stage 1: Proof of Concept/Initial Testing**
  Stage 1 grants support the introduction of a solution in a developing country context to gain an early, real-world assessment of the solution. This includes testing for technical, organization, distribution, and financial viability. Key activities could include assessing user demand, willingness to pay, and correct usage of products and services, as well as documenting social outcomes and real world costs to implement the solution. Stage 1 funding levels range from $25,000 to $150,000 per project and can support activities for up to two years.

- **Stage 2: Testing and Positioning for Scale**
  Stage 2 grants support testing for social impact, improved outcomes and/or market viability, as well as operational refinement to build paths to sustainability and scale. Stage 2 applicants should have already met all the requirements of a Stage 1 project described above. Stage 2 funding levels range from $150,000 to $1,500,000 and can support activities for up to three years.

- **Stage 3: Transitioning Proven Solutions to Scale**
  Stage 3 grants support transitioning proven approaches to scale, which could include adaptation to new contexts and geographies. Operational challenges for scaling should be identified and addressed as a way to refine the scaling-up process. Stage 3 applicants must explain how they will use DIV funds in a catalytic fashion and demonstrate ability to obtain necessary resources outside of DIV funds. Stage 3 funding and support provides a platform for applicants to grow while engaging additional partners who will help scale the project beyond DIV support but for project applicants for whom more evidence of success and track record are needed. Stage 3 funding levels range from $1,500,000 to $15,000,000 and can support activities for up to five years.

DIV selects projects to fund based on:

- ***Cost Effectiveness***—DIV seeks applications that have the potential to deliver greater development impacts per dollar than standard practice.
- ***Rigorous Testing***—The DIV model emphasizes testing potential solutions and evaluating impacts to identify what works and what does not, and to help scale only those proven solutions.
- ***Pathways to Scale***—Innovations are expected eventually to be scaled up through both the public and private sectors, or in some cases a combination of the two. Public sector scaling plans demonstrate that grantees are likely to compel host country governments, multilateral donors, or other public sector players to scale the innovation. Grantees who expect to scale through the private sector will plan to achieve commercial viability themselves, or convincingly demonstrate that other businesses will scale their innovation, or a combination of both.

Cosecha: A Rainwater Harvest Project in Southern Honduras is in the "testing and positioning for scale" phase—a DIV Stage 2 funded project. This EA is limited to the proposed 10 research sites in the target region in Southern Honduras.

2.2 SUMMARY OF THE REGULATORY FRAMEWORK

USAID'S 22 CFR 216 REQUIREMENTS

USAID's Environmental Procedures, 22 CFR 216 (also known as Reg. 216), govern the environmental review process for all projects, programs, or activities supported by USAID. In accordance with 22 CFR 216.2(d), the following are among the *Classes of Actions Normally Having a Significant Effect on the Environment*, which require an Environmental Assessment (EA):

- River basin development projects;
- Irrigation or water management projects, including dams and impoundments;
- Agricultural land leveling; and
- Drainage projects.

The proposed rainwater harvesting and associated irrigation schemes fall under these four categories when considering all phases of the project (construction through operation).

In accordance with Reg. 216, scoping—the first phase of the EA process—began with the identification of potentially significant issues related to the proposed action and the determination of the scope of the issues to be addressed in the follow-on EA. The Scoping Phase culminated in the approval of the Scoping Statement by the USAID Bureau Environmental Officer (BEO) in October 2015.

The general purpose of the EA, according to 22 CFR 216.6(a), is to provide USAID and host country decision-makers with a full discussion of significant environmental impacts of a proposed action. The EA includes alternatives that would avoid or minimize adverse impacts or enhance the quality of the environment so that the expected benefits of development objectives can be weighed against any adverse impacts or any irreversible or irretrievable commitment of resources. BEO approval of the EA must be obtained prior to implementation of the subject EA activities. Once the BEO approves the EA, the mitigation measures (in the Environmental Mitigation & Monitoring Plan) must be implemented.

HONDURAS' POLICY AND INSTITUTIONAL FRAMEWORK FOR RAINWATER HARVESTING AND ENVIRONMENTAL IMPACT ASSESSMENT

As described in the Scoping Statement, the Honduran Government has already reviewed and approved the rainwater harvesting project and determined that it would not need to undergo the Honduran environmental impact assessment process. Therefore, this EA is being prepared to comply with the USAID's Reg. 216, and the document will not be provided for review by the Honduran authorities.

The potentially applicable legislative and regulatory instruments related to use and management of water in Honduras are listed in Table 4. Given that the Honduran government has already approved the project, this section lists key policies that address the design and implementation of project.

The *Cosecha* project was classified by the Honduran authorities (formerly SERNA, now Mi Ambiente) as a Category 1 project under the Honduran Environmental Law and the Regulation of the National System for Environmental Impact Evaluation (SINEIA) Agreement No 189-2009. Category 1 projects include activities or projects that are considered to have potentially low environmental impact or risk. Under Honduran law, scoping processes, public participation, and/or EIA are not required for Category 1 projects. However, Category 1 projects still must comply with all environmental laws and policies as well as any monitoring requirements. The regulatory framework of Honduras' National EIA system indicates that the public must be informed at the inception of all EIA processes. Given that the *Cosecha* project is not required by the Government of Honduras to prepare an EIA, the public notice requirement is not applicable to the project. Furthermore, if the project were subject to an EIA, Honduran law does not require a scoping process but rather instructs the project proponent to directly develop the EIA. Since a high level of community support and investment are required for the *Cosecha* project, Global Communities has already undertaken extensive outreach with the affected communities, and this EA is being undertaken to comply with USAID requirements.

Table 4 Legislation and Regulation Related to Use and Management of Water in Honduras

LAW/REGULATION	DECREE/AGREEMENT NUMBER
General Water Law	Decree 181-2009
Land Use Law	Decree 180-2003
4.1.1.1 Reforms to the General Law of Public Administration	4.1.1.2 218-96
4.1.1.3 Law of National Use of Water	4.1.1.4 137
4.1.1.5 General Environmental Law	4.1.1.6 104-93
4.1.1.7 Health Code	4.1.1.8 65-91
4.1.1.9 National Technical Standard for Drinking Water Quality	4.1.1.10 84-95
4.1.1.11 Law of SANAA	4.1.1.12 91
4.1.1.13 Fishing Law	4.1.1.14 154
4.1.1.15 Law of Organic Marine Merchants	4.1.1.16 167-94
4.1.1.17 Forestry Law	4.1.1.18 85
4.1.1.19 Civil Code	4.1.1.20 76
4.1.1.21 Municipality Law	4.1.1.22 134-90
4.1.1.23 Law for the Modernization and Development of the Agricultural Sector	4.1.1.24 31-92
4.1.1.25 Law of COHDEFOR (now called the Institute for Conservation of Protected Forest Areas and Wildlife)	4.1.1.26 103 (Decree Law)
4.1.1.27 Law of the Honduran Institute of Tourism	4.1.1.28 103-93
4.1.1.29 Law of ENEE	4.1.1.30 48

LAW/REGULATION	DECREE/AGREEMENT NUMBER
4.1.1.35 Constitutive Act for Marine and Freshwater Projects	4.1.1.36 656
4.1.1.37 United Nations Framework Convention on Climate Change	4.1.1.38 26-95
4.1.1.39 Environmental Health and Sanitation Regulations	4.1.1.40 Agreement 470
4.1.1.41 Regulations of the General Environmental Law	4.1.1.42 Agreement 109-93
4.1.1.43 Regulations of the Municipality Law	4.1.1.44 Agreement 18-93
4.1.1.45 General Forestry Regulations	4.1.1.46 Agreement 634-84
4.1.1.47 General Environmental Health Regulations	4.1.1.48 Agreement 94, Gazette N° 28,593
4.1.1.49 Technical Standards for Wastewater Discharges to Receptors and Sewage	4.1.1.50 Agreement N° 058 Gazette December 13, 1997
4.1.1.51 Regulation of Land Use	4.1.1.52 Agreement 25-2004
Law for the Modernization and Development of the Agricultural Sector	Agreement 31-92
Law for Patronage and Community Association	Decree 253-2013

Source: Center for Information on Legislative Studies (CIEL); Compendium of Environmental Legislation, Honduras 2011, Compiled by Attorney Edwin Natanael Sanchez Navas

2.3 PURPOSE OF AND NEED FOR THE PROPOSED PROJECT

The Corredor Seco of Honduras is characterized by irregular precipitation and prolonged periods of extreme heat, called the "canícula" (SERNA, 2014). During El Niño events, precipitation decreases by 30-40 percent in Southern Honduras, resulting in drought and loss of crops (SERNA, 2014). The targeted departments in the *Cosecha* project are considered particularly vulnerable to both drought and flooding, which disproportionately affects those with few economic resources, such as smallholder farmers. Therefore, there is a need to improve agricultural production, decrease malnutrition, and enhance the region's resilience to the impacts of El Niño events and climate change by harvesting rainwater for use in drier periods of the year.

The *Cosecha* project aims to test the impact of rainwater harvesting on agricultural production as a means to enhance resiliency to drought and other climate variability in Southern Honduras and to demonstrate the feasibility for larger-scale implementation. As an empirical test, the project will use a methodology that selects a representative sample of potential reservoir sites, captures costs and benefits (in terms of farmer income), and evaluates broader social and environmental benefits. Separate treatment groups will be used to quantify the benefits to (1) a rainwater harvesting technology intervention package plus technical assistance, (2) technical assistance only, and (3) the baseline (e.g., the control, or no technology or technical assistance). As a result, information from this project may provide valuable insight for future rainwater harvesting projects from design to implementation, operation, and maintenance.

PROJECT DESCRIPTION

Lack of access to water is a global development challenge. The World Bank has estimated that world food needs will double by 2030, and 60 percent of this quota will need to be met by irrigated agricultural crops. However, access to fresh water is limited, and management of these water resources is a challenge in countries around the world (SEI 2009). In the context of increased demand for food and increased water scarcity, one recommended approach to improving agricultural production is to increase crop yields on existing agricultural lands, rather than clearing more land for food production (FAO 2009).

Irrigation can support increased production on croplands, but access to irrigation in Latin America is limited. Without irrigation, farmers typically only produce one crop per year, which can fail due to unpredictable rainfall and/or drought. For example, over a million smallholder farmers in Honduras, El Salvador, Guatemala, and Nicaragua produce 70 percent of the maize and 100 percent of the beans consumed locally

(Eitzinger et al 2012), with farmers depending on these crops for income, and local communities depending on these crops for subsistence.

The *Cosecha* project aims to measure the impact of small-scale reservoirs and ultra-low drip irrigation systems on the incomes and food security of smallholder farmers in Southern Honduras. In coordination with the Honduran Ministry of Agriculture (MoA), the International Center for Tropical Agriculture (CIAT), and the Agrolibano Foundation, Global Communities will develop 10 small-scale reservoir sites to evaluate how the jointly-owned and -managed reservoirs—combined with technical assistance to improve agronomic practices—drive producer group formation, increase yields and household incomes, and provide social and environmental benefits. Project responsibilities (by project partner) include:

- **Global Communities:** General project coordination; assessment of baseline conditions; technical assistance in infrastructure and irrigation; site selection, design, and construction of the reservoirs; follow-on support for management of the reservoirs.

- **Ministry of Agriculture**: Secretary of Agriculture and Livestock: Provision of ultra-low drip irrigation for 200 parcels of a quarter of a hectare each; technical assistance for production and access to markets.

- **International Tropical Agriculture Center (CIAT):** Experimental design; baseline condition analysis; data collection, analysis, and dissemination of results; GIS analysis support.

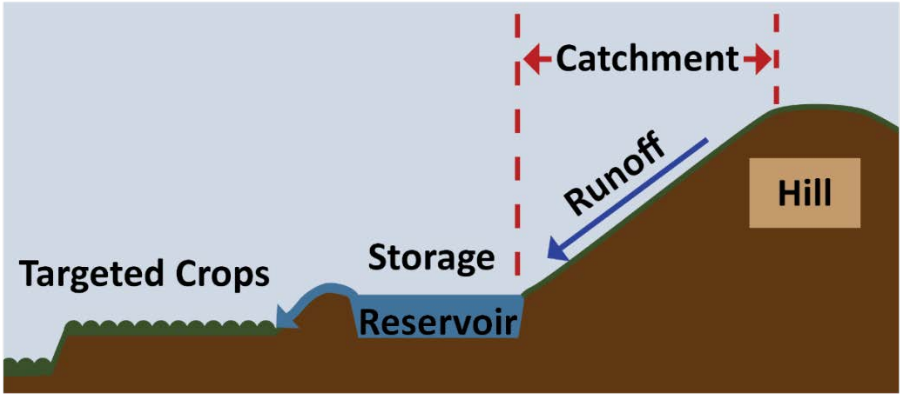
- **Agrolibano Foundation:** Provision of heavy equipment for reservoir construction; technical assistance and support for community group formation; ongoing technical assistance for reservoir operation and maintenance.

METHODOLOGY

The *Cosecha* project will use a randomized controlled trial (RCT) methodology to evaluate whether and how small-scale reservoir sites and technical assistance improve agronomic practices, drive producer group formation, increase yields and household incomes, and provide social and environmental benefits. The project aims to measure: (1) impacts of water harvesting interventions on crop yields, farm profits, poverty, food security, employment generation, gender inequality, group empowerment, and environmental outcomes; and (2) impacts of improved agronomic practices on the same outcomes. The sites for the 10 reservoirs were selected from a group of 40 to 50 potentially suitable sites within five target departments where the Government of Honduras committed counterpart funding via the EmprendeSur program.

Water harvesting is the collection of rainwater from winter streams or surface runoff that is directed to a storage reservoir for later use in agricultural production. The water harvesting system consists of a runoff area, usually an existing stream channel that collects in a storage area (the small reservoir), with overflow running off into the downstream streambed (Figure 2). This is made possible through the construction of simple water catchment and irrigation infrastructure, combined with the development of complementary irrigation systems at the smallholder farm level. Based on the Global Communities experience with the original nine pilot reservoirs (one of which was visited by the Scoping Team), the estimated water storage capacity of the 10 research sites of the *Cosecha* project will be between 6,000 to 35,000 m^3.

Figure 2. General Design for the Rainwater Harvesting Project



Source: Global Communities

In addition to the 10 farmer communities that will receive drip irrigation services with water supplied by the 10 reservoirs, two treatment groups of 200 households each will also purchase directly—or receive logistical support from non-USG sources (such as Foundation Agrolibano, FAO, the MoA or international NGOs) to purchase directly—a standard set of inputs including improved seeds for maize, beans, papaya and watermelon; access to fertilizer; and training in improved agronomic practices.

The *Cosecha* project will also experiment with loan products to finance reservoirs and drip kits and to survey farmers from the pilot reservoirs to measure spillover effects, long-term profitability, and sustainability of the project. While Global Communities' activities take place in vulnerable communities throughout Southern Honduras, the reservoir project focuses on 39 communities specifically, 30 of which are included in the research phase (10 reservoir and 20 comparison sites). The 10 reservoirs in the research phase are the focus of the Scoping Statement and this EA. Additionally, the project design includes policy dialogue and learning exchanges with key stakeholders from Mexico, Central America, Bolivia, Colombia, Ecuador, and Peru. The *Cosecha* team will evaluate the impacts of the rainwater harvesting project and summarize key lessons and best practices so that other organizations can replicate the methodology. The *Cosecha* project will analyze how best to mainstream the action into public policy, select appropriate sites, and apply targeted subsidies to stimulate private investment in water harvesting and drip irrigation based on project's high return on investment (ROI). Finally, the *Cosecha* project will disseminate key lessons and best practices for others to scale the project on a national level, while also working with networks of microfinance institutions (MFIs), input distributors, business associations, research institutes, donors, and development practitioners to promote the project internationally to attract both public and private sector buy-in and investment.

SITE SELECTION

Global Communities and Agrolibano Foundation technical staff were responsible for selecting the participating communities and 10 rainwater harvest reservoir sites. Information relevant to selecting communities and reservoir sites was obtained through consultations with local leaders, municipal authorities, and direct beneficiaries, and this information complemented information gathered from interviews with other programs working in the region. The sites were selected based on the following criteria (Tables 5, 6, and 7).

Table 5 Criteria used to identify potential rainwater harvesting sites

CATEGORY	CRITERIA
Topography	*Suitable sites occur where rain flows between two natural ridges and converges in a low and narrow area*

CATEGORY	CRITERIA
Specific requirements:	• Lengthwise and traversing slope should be between 2-4 percent (the longer the lengthwise pitch, the lower the volume of the reservoir) • Length of the reservoir should be twice the length of the dam • Reservoir should be located above the cultivated land
Reservoir and Recharge zone	*The filling of the reservoir depends on the recharge zone. The larger the area from which the reservoir draws the rain runoff (recharge area), the faster the reservoir is filled*
Specific requirements:	• Land area ratio (water source area [micro watershed] to cultivated land) of 10:1 • Slope of the water discharge site to the dam is at least 5 percent • Runoff should run down land with good plant cover, thus minimizing erosion potential • If the recharge zone does not have sufficient vegetation cover, erosion prevention measures such as construction of canals, rock walls, and live barriers may be developed
Earthen dam	*To decrease costs, the reservoir dam will be constructed using locally available materials*
Specific requirements:	• Soils should have a high clay content and should be compactable, non-permeable, and structurally stable • There should be silt or mud on site or near the site to prevent leakage through the bottom of the cut-off trench • A minimum of 50 percent of the construction materials should be sourced from the reservoir, and the remaining material may be sourced from the surrounding area • Maximize the height of the dam to increase water depth and minimize losses due to evaporation (the larger the reservoir area, the greater potential water loss due to evaporation), while still permitting reservoir overflows to maintain consistent water flows downstream
Land inside the reservoir footprint	*To minimize loss of habitat or forests, the sites that will be inundated once the reservoirs are filled were evaluated for existing plant cover*
Specific requirements:	• High clay and silt content in the soils • Few trees • Little to no exposed rock (preference is for no rock) • No or only a few plants/trees exceeding 60 cm in height • Less than 2 percent soil infiltration

Table 6 Other Criteria used to identify potential rainwater harvesting sites

CATEGORY	CRITERIA
Topographical analysis	*After a potential site has been identified, a topographical analysis was undertaken to determine:*
	• Length of the earthen dam • Height of the dam • Maximum water level • Area of the reservoir • Volume of soil needed for the earthen dam • Volume of the reservoir • Efficiency index • Wall stability

Table 7 Criteria used to identify farmers' eligibility to use the irrigation systems

CATEGORY	CRITERIA
Requirements for inclusion in irrigation system	• Small farmers, experienced in cultivation • Good with teamwork • Proactive, assertive attitude • Follow the norms of use such as: care of the irrigation system, efficient water use, environmental sustainability • Potential for in-kind labor contribution by the farmers • Potential for third-party co-financing (for example, from village banks) • Clearly defined land tenure of both the reservoir site and the producer plots • Number of farmers that will benefit from the system

The 10 reservoir sites included in the *Cosecha* project and this EA are listed in Table 8.

Table 8 Reservoir Sites and Municipalities

DEPARTMENT	MUNICIPALITY	COMMUNITY	# FAMILIES
Choluteca	Namasigue	La Constancia	20
Choluteca	Namasigue	San Rafael 2	20
Choluteca	Namasigue	Las Pilitas 2	20
Choluteca	Namasigue	Vuelta al Cerro 2	20
Choluteca	El Triunfo	Altos de Doña Julia	10
Choluteca	Namasigue	Santa Irene 1	13
Valle	Nacaome	Altos El Estiquirin 2	12
Valle	Nacaome	El Tamarindo 2	5
Valle	Nacaome	Chaguite	4
Choluteca	Namasigue	Vuelta al Cerro 1*	To be determined

*Global Communities identified this as the tenth site after the Scoping Team had departed Honduras.

3.0 ALTERNATIVES, INCLUDING THE PROPOSED ACTION

As required in 22 CFR 216.6(c) (3), Section 3 explores reasonable alternatives that meet the purpose and need of the project (Section 2.3), devoting substantial treatment to each alternative, including the proposed action (Section 3.1); briefly discusses alternatives that the EA Team eliminated from inclusion in the EA (Section 5.1); presents environmental impacts of each alternative in comparative form (Sections 5.2 and 5.3); and includes appropriate mitigation measures (Section 6.0).

Reasonable alternatives to the proposed action that meet the project purpose and need (Section 2.3) are described below, followed by a description of alternatives eliminated from further study. After the alternatives description, the alternatives being evaluated in this EA are presented in comparative form in a matrix, showing how they rank against the potential significant issues identified in the Scoping Statement. Section 5 of this EA contains a detailed analysis of environmental consequences, based on the significant issues, of the proposed action and the alternatives.

3.1 PROPOSED ACTION

The proposed action is to construct 10 rainwater-harvesting reservoirs and study on their efficacy (plus drip irrigation) on agricultural production. This approach, if effective, will provide an important alternative to traditional methods (i.e., the No Action alternative) and enhance resiliency to drought and other climate variability in Southern Honduras. The southern region of Honduras is one of the most water-stressed areas of the country and receives less precipitation and has less groundwater recharge potential than other parts of Honduras. Given the increasing irregularity of precipitation in the region, rainwater harvesting technology has the potential to provide a more reliable source of water for agricultural purposes with potentially low impact to forests and other natural resources.

In the pilot phase, the *Cosecha* project increased farm income, improved crop yields, and improved household food security at nine reservoir sites. As a project designed for "testing and positioning for scale," it will allow Global Communities to measure the effect of these potential significant impacts on several outcomes among project beneficiaries. The project's goal is to provide evidence of whether and how reservoirs, combined with ultra-low drip irrigation and improved agronomic practices, drive producer group formation, increase harvests and household income, and provide social and environmental benefits. Expected outcomes are:

- Improved incomes for famers, their families, and their communities;
- Improved agricultural practices via technical assistance targeting soil conservation practices, soil fertility, use of ultra-low drip irrigation, and improved cultivation methods, among others;
- Provide social and environmental benefits, including the formation of farmer associations at each reservoir site; increased reliability of subsistence crops for household consumption; potential for cultivation of cash crops, such as watermelon; more efficient use of cultivated lands; and efficient use of limited water for irrigation; and
- Demonstrate the efficacy of rainwater harvest compared with existing practices.

3.1.2 PROJECT BENEFICIARIES

The project beneficiaries are the smallholder farmers and their families who participate in the communal reservoir program. According to the implementing partner, the project will benefit at least 220 people who will be trained to construct, maintain, and manage the rainwater harvest system; use good agricultural practices; and use the ultra-low drip irrigation systems. If there is sufficient water supply at the sites, the groups could expand in the future to benefit additional families.

3.1.3 SITE DESCRIPTION

The proposed action will construct 10 small-scale reservoirs at sites in the departments of Valle and Choluteca in Southern Honduras. According to the FAO, irrigation in Honduras is concentrated in northern Honduran departments of Cortes, Yoro, La Paz, and Comayagua, with less expansive irrigation in the Choluteca and Valle regions (FAO 2015). The 10 sites were selected based on physical conditions at the site, including land use, topography, soil type, availability of local material for the earthen dams, and community support for the project (See Tables 5, 6, and 7). In August 2015, the Scoping Team visited nine of the 10 proposed rainwater-harvesting sites.

The project components will include:

- Design and construction of the small scale reservoirs in existing stream channels;
- Construction and installation of a small concrete platform and water storage tanks and PVC pipes to move water from reservoirs to the fields;
- Installation of flexible plastic tubes for micro-drip irrigation in the agricultural plots;
- Training in operation and maintenance of all irrigation equipment;
- Technical assistance for crop selection and cultivation;

According to the implementing partner, the cost to construct the reservoir is approximately US$15,000, plus approximately US$1,000 for the irrigation equipment. All sites are accessible via primary or secondary roads, and no roadway construction is anticipated for the project. Detailed site descriptions are included below and are largely taken from the *Scoping Statement for Cosecha: A Rainwater Harvesting Project in Southern Honduras*.

LA CONSTANCIA, NAMASIGUE, CHOLUTECA

The proposed site of La Constancia is located in the Namasigue Municipality, Choluteca Department. The projected volume of the reservoir is 5,833 m^3. The reservoir site is a shallow basin with uniform sloping sides that will capture water from an ephemeral stream. The stream channel is characterized by a rocky streambed with incised and eroded banks and with limited riparian vegetation. The water catchment area above the reservoir is lightly forested and grazed by cows. The community members indicated a desire to participate in reforestation efforts.

Generally, the reservoir site is a wide field covered in grasses. Community members previously excavated the site in an unsuccessful attempt to harvest rainwater and runoff, and the previously excavated area is surrounded by a berm and filled with grasses. Immediately surrounding the proposed site is grazed and cultivated land and a few houses near the proposed lagoon. The access road is a route across from a soccer field and is accessible via dirt road.

The lagoon will inundate the grassy field and will capture water from an ephemeral stream that runs through the site. The streambed is incised and rocky, and upstream from the site is mostly mixed secondary forest and shrubs. Downstream from the reservoir site there is prominent riparian vegetation in a narrow strip along the streambed. This riparian area is only about 35 m long and about 15 m wide, and below the band of riparian vegetation the streambed widens into a grassy field. The site is 300 to 400 m from irrigation plots.

The agricultural fields are located downstream of the reservoir, and the most common crops currently include beans, corn, and cashews. Approximately 20 individuals and their families will benefit from the project and plan to use the water to irrigate subsistence crops as well as family gardens. Potential future uses of water include cultivation of vegetables, watermelon, sesame, cane, pasture land, etc. Currently, the group does not have a plan for management of allocation of water, especially if other community members express interest in accessing water from the lagoon. The group did not indicate that they intend to use tilapia to manage mosquitoes. The community should have a plan to manage mosquitos and protect community members from mosquito-borne diseases.

Given the current condition of the site, filling the reservoir will not cause deforestation or loss of trees in the footprint of the reservoir site. The largest potential impact at this site is potential loss of environmental flows downstream. The design of the reservoir allows for spillover into the existing stream channel, but it is not clear how much water will flow downstream once the reservoir is constructed. Maintenance of environmental flows to maintain the limited riparian vegetation is an important consideration for the site. As recommended for all the sites, the earthen dam and newly excavated slopes of the reservoir should be stabilized with a fast-growing native grass, such as the native star grass and/or legumes to enrich the soil.

SAN RAFAEL 2, NAMASIGUE, CHOLUTECA

The proposed reservoir in San Rafael 2 will have a volume of approximately 12,000 m^3 and is located at the base of a small valley. The land use conditions in the upper part of the micro-watershed are mixed trees and shrubs while the hillsides bordering the proposed reservoir site are grazed. The proposed reservoir site is an ephemeral stream in a ravine, which will be blocked with an earthen dam to hold water. The dam will inundate an area that is currently covered by shrubs and grasses and a few trees. Access to the site is on a dirt road and a short trail, and a new access road is not anticipated for the site.

Downstream of the reservoir site there is an area of mature riparian vegetation characterized by a mix of shrubs and several mature trees. The earthen dams are designed to allow for overflow into the existing streambed, and maintaining environmental flows at this site will be particularly important to maintain the existing healthy riparian vegetation.

Land use around the proposed reservoir site is mixed and is lightly forested, grazed, and/or cultivated. The primary crops currently include corn, green beans, beans, and stover for livestock. There is very limited water for crops in the community, and farmers often water crops by hand using a small nearby water source that is reportedly drying up. With only rain fed agriculture, the farmers typically plant and harvest twice a year. A more reliable water source would enable them to plant and harvest three to four times a year. The farmer group reported that with a more reliable water source, they would like to grow crops that could be sold, such as squash, peppers, cucumbers, and pumpkins. The plots that will be irrigated are located below the reservoir site, and there is minimal risk of contamination of the reservoir by agro-chemicals.

Currently, the group does not have a plan for management of allocation of water, especially if other community members express interest in accessing water from the reservoir. There is a strong forest management ethic in the community whereby cutting trees is not allowed unless it is specifically for home construction. In the case of timber harvest for home construction, harvest is not allowed in riparian areas or in the upper part of the micro-watershed. The group did not discuss how the project would manage increased mosquitos.

Given the current condition of the site, the potential for landslides in the upper watershed and erosion elsewhere at the site appear to be minimal. The main concern at this site is the potential impact on the altered environmental water flows on the well-developed riparian area downstream of the proposed reservoir, which likely serves as habitat for a variety of species, potentially including sensitive species, although no record of sensitive species exists for this area. Maintenance of environmental flows to support downstream riparian vegetation is an important consideration for the site.

Excluding livestock access is also an important recommendation for the reservoir site given the high intensity of grazing on surrounding lands. Livestock could negatively impact the functioning of the reservoir by damaging the earthen dam and sides of the reservoir and contaminating the water with feces and fecal-borne pathogens.

Finally, the community should have a plan to manage mosquitos and protect community members from mosquito-borne diseases.

VUELTA AL CERRO 1, NAMASIGUE, CHOLUTECA

The Vuelta al Cerro 1 rainwater harvesting site is designed to hold approximately 9,300 m^3 of water and will benefit a group of 14 families with eight to 10 members per family. The site is a shallow, wide basin largely denuded of vegetation due to intense cattle grazing and removal of vegetation for cultivating crops. The conditions in the upper watershed are mixed use. Generally, the ridges and crests of the hills are forested, and the hillsides are heavily grazed. Filling the reservoir will impact about four to five trees. The area is generally not good habitat for wildlife given the high intensity of grazing at the reservoir site. However, the community plans to reforest areas in the vicinity of the reservoir.

The reservoir site is transected by a shallow ephemeral stream channel that will be blocked with an earthen dam at one end. About 100 m below the reservoir site, the tributary stream meets with a larger stream that is at least two to three times larger in width and depth. During rain events, the larger stream channel moves the majority of the water downstream. Thus it appears that the small stream that will be used for the reservoir will not significantly disrupt environmental flows. This reservoir, however, might be more susceptible to evapotranspiration than other reservoirs due to its broad and shallow shape.

Currently, the farmer group plants corn and beans for household use, and about four or five of the group members also have five to 10 head of cattle. With a more reliable source of water, the farmers would cultivate vegetables, watermelon, sesame, cane, cassava, sweet potato, fruit trees, etc. The community does not have a structure or process to manage requests from other communities to use the reservoir. One community member suggested that the decision to allow more beneficiaries should be based on the volume of water available. The group stated that they would stock the reservoir with tilapia to manage mosquitos, although the group did not have much knowledge of the lifecycle of tilapia or how the tilapia would be managed.

There is community interest in reforesting the hillsides around the reservoir with a mix of fruit trees for additional income, as well as with native trees. The fruit trees of interest include mango, orange, and cashew trees, while the native tree species include Guanacaste, mahogany, cedar, and laurel. The community group would benefit from technical assistance for the entire process of reforestation, from species selection to cultivation and site selection for reforestation efforts.

Given the highly impacted nature of the site and compacted soils from cattle grazing, development of the reservoir itself will not cause loss of existing forest or threatened or endangered species. Furthermore, given the large primary stream channel adjacent to and below the site, environmental flows are less of a concern at this site, and the major concerns are related to potentially high rates of evapotranspiration given the reservoir's size and depth, sedimentation due to eroded hillsides, and the potential impact of cattle on the reservoir and its water quality. Nonetheless, maintenance of environmental flows to preserve downstream riparian vegetation is still an important consideration for the site.

LAS PILITAS 2, NAMASIGUE, CHOLUTECA

The Las Pilitas reservoir site is designed to hold approximately 14,000 m^3 of water and benefit about 20 families, with approximately six members in each family. Access to the site is via a secondary dirt road in good condition; the project site is located approximately 100 m from the road. About five years ago, the community excavated an area adjacent to a main road to collect water for irrigation, and the proposed new reservoir is located directly above the old retention pond. During the scoping team's visit in August 2015, the old pond still retained a small amount of water in an unusually dry year. The team observed bird activity around the existing pond, and community members reported other wildlife such as armadillo, paca (a small rodent), and ocelots near the existing pond. Some of these animals are hunted for supplemental food for families.

The area to be inundated by the new reservoir is located directly above the existing water retention pond, appears lightly grazed, and does not appear to be critical wildlife habitat. There are approximately 12 to 15 trees located in the reservoir's area of impact. Several existing ephemeral streambeds on the site are overgrown with grasses and brush while the land use conditions in the upper part of the watershed are a mixture of sparse forest, grazed hillsides, and some cultivated areas. The existing retention pond is located adjacent to a road with culverts that convey any overflow from the existing pond to the stream channel downstream of the road. Across the road, on the downstream side, there is an existing second-growth forest that appears to provide good habitat for birds and wildlife. Maintaining environmental flows from the reservoir site under the road and into this downstream forested area is critical for maintaining ecosystem function.

The community currently cultivates staple crops such as corn and beans in fields located below the proposed reservoir site. With a more reliable water source, however, the farmers would like to diversify their crops to include sweet pepper, cucumber, potatoes, bananas, watermelon, and sweet potato for both personal consumption and income. No members of the community group have livestock, but some do raise chickens and pigs. The scoping team observed pigs wallowing in the existing retention pond; it will be important to exclude all livestock, including pigs and cows, from the reservoir.

The proposed reservoir site is located in an area without existing homes, and the community does not view mosquito management as a priority at this site. They are not considering use of tilapia for mosquito management. However, the community group did express concerns about the earthen dam failing and the potential for water to flood the road, which is a main thoroughfare for the surrounding villages. Lack of maintenance of the culverts could cause water to overflow the road. Thus keeping the culvert free of litter and maintaining the earthen dam should be a high-priority aspect of the project's design and management.

The community group has limited experience with reforestation and has received some technical assistance in reforestation techniques from government agencies. Group members suggested planting Guanacaste, mahogany, acacia, neem, and melina trees as part of a reforestation effort. The community would benefit from technical assistance related to reforestation and the operation and management of the reservoir. Given the impact on existing mature trees onsite and the limited forested hillsides above the proposed reservoir, benefits from reforestation include erosion control, development of a sustainable source of firewood, provision of wildlife habitat, and potential groundwater recharge from the reservoir. Maintenance of environmental flows to support downstream riparian vegetation is an important consideration for the site. As recommended for all the sites, the earthen dam and newly excavated slopes of the reservoir should be stabilized with a fast-growing native grass, such as the native star grass and/or a legume to enrich the soil.

ALTOS DE DOÑA JULIA

The proposed reservoir site at Altos de Doña Julia is designed to hold approximately 16,500 m^3 of water, benefiting approximately 10 families with an average of six members each. Slash and burn agriculture and cattle grazing heavily impact the site. As a result, the site is generally denuded, and much of the area is exposed soil. The site is accessed by road and through a farm and agricultural field. The hillsides in the watershed are sparsely forested, and there are some tall shrubs on the perimeter of the property. About 25 m downstream of the reservoir site is a small stand of riparian vegetation in the streambed. The ephemeral stream that runs through the property will be blocked with an earthen dam creating a shallow and long retention pond. With this design, the potential for evapotranspiration may be large. Community members indicated that they would like to use tilapia for mosquito control; this technique will have to be carefully considered to avoid unintended impacts on native aquatic species. Technical assistance in management of tilapia should be integrated into the technical assistance package for the community.

The environmental condition of the site is poor because the soil has been compacted by cattle grazing, and most vegetation has been removed via slash and burn agriculture. There are approximately eight to 10 medium trees that will be inundated by the reservoir; these trees are dispersed and do not comprise a forest stand. Despite heavy use of the site's natural resources, community members report observing wildlife in the area, including rabbits, snakes, deer, pacas, and armadillos. There is occasional subsistence hunting.

The community currently uses a 200' deep well to supply water for livestock. There is not, however, sufficient supply for irrigation of crops. The cultivated plots that will be irrigated are located below the proposed reservoir site, and there is limited use of pesticides and fertilizers. When there is adequate rainfall, the community grows sweet potato, yucca, corn, beans, and sorghum, but, like much of the region, there has not been adequate rainfall in 2015 to cultivate these crops.

The reservoir will not affect forests in the planned reservoir area, and the primary concerns at the site are related to training for reforestation; management of the reservoir, especially to avoid rapid evapotranspiration; excluding cattle from the reservoir to protect the integrity of the dam and earthen sides of the reservoir and its water quality; and use of tilapia for mosquito management since none of the farmers have experience in aquaculture. Training in techniques to manage tilapia will be essential to avoid unintended environmental impacts and to successfully use tilapia as mosquito control. Maintenance of environmental flows to support downstream riparian vegetation is also an important consideration for the site.

SANTA IRENE 1, NAMASIGUE, CHOLUTECA

The proposed reservoir site in Santa Irene 1 will benefit 13 families with an average of five to six members per family. The reservoir capacity is about 15,500 m^3 and is located in an open, shallow, saucer-shaped area of land that is heavily grazed and affected by slash and burn agriculture. It is accessed by a road, and no additional road building will be required. There are several trees at the reservoir site; the hills above the reservoir site have been grazed by cattle and have few trees. The streambed is gravelly, and there is some bank erosion within the stream channel. On both sides of the ephemeral streambed at the proposed reservoir site, the soil is compacted, grazed, and sometimes burned. About 50 m below the reservoir site there is limited riparian vegetation with scattered large trees in the ephemeral streambed. Maintenance of environmental flows to support the downstream riparian vegetation is an important consideration for the site.

The landowner has 250 head of cattle, which have grazed large areas in and around the proposed reservoir site. Given the large number of cattle, it will be important to remove cattle from the reservoir in order to maintain structural integrity of the reservoir and prevent water contamination. Furthermore, the cattle might prevent successful reforestation efforts by grazing new young trees and shrubs. Thus a comprehensive plan for livestock management is particularly relevant at this site.

In years with regular precipitation, community members cultivate corn, beans, and sorghum, but to date the families have been unable to cultivate crops because of drought in the region. If water were more readily available, community members would like to plant trees such as almond, cashew, mango, and nance (*Byrsonima crassifolia*). In addition to planting trees for nuts and fruits, the group expressed interest in reforestation and suggested species such as laurel, mahogany, and cedar. The group also suggested planting eucalyptus trees for a fast-growing source of firewood; however, eucalyptus is NOT recommended because it is a non-native invasive species that uses significant amounts of water. The community group would benefit from technical assistance for reforestation, including species selection, nurseries, and maintenance of the young trees.

The proposed site is located within a kilometer of a school, and the community expressed two concerns in that regard: 1) if the dam fails, it might flood the school; and 2) the reservoir might be a breeding ground for mosquitoes, which the community would like to control. The school is located at a higher elevation than the proposed reservoir site, and in the unlikely event of failure of the earthen dam, the reservoir is designed to follow the existing stream channel, which has not historically affected the school. The community proposed using tilapia or shrimp to manage mosquitoes. Although a few members of the community have experience in shrimp aquaculture along the coast, specific training on use of tilapia, a freshwater species, will be important for long-term successful management of mosquitoes.

The community group is newly formed and has not yet considered how they will manage the water resource, especially if other community members wish to use the water for irrigation. As with most of the other sites, the reservoir will not inundate forests, and the primary concerns at the site are related to training for reforestation, management of the reservoir and mitigation of rapid evapotranspiration, and training in use of tilapia for mosquito management. Maintenance of environmental flows to support the downstream riparian vegetation is an important consideration for the site. Given the large number of cattle at the site, developing a management plan to exclude cattle from the reservoir and recently reforested plots is an important management measure. Finally, this site has additional social concerns related to the proximity of the school to the site, mosquito management, and weak group cohesion for management of the water.

ALTOS DEL ESTIQUIRIN, NACAOME, VALLE

The site selected for construction of rainwater harvest is known as Cerro Las Marias, and the projected volume will be 4,300 m^3. Approximately 12 families will benefit from access to stored water for ultra-low drip irrigation. Access to the site is via an unimproved road and is located a short distance across agricultural fields. No access-road construction will be required.

The proposed reservoir site is located at the base of steep forested hillsides and is adjacent to watermelon and bean fields. The stream channel feeding the reservoir is very rocky, steep, and narrow; as the stream enters the reservoir site, one side of the reservoir has a more gradual slope (~20 degrees) versus a steeper slope (~35 degrees) on the opposite side. Based on stream channel morphology, a high volume of water moves rapidly through the system. Accordingly, the design plans include construction of a dike at the upper end of the reservoir to slow the velocity of water entering the reservoir.

There are about five large (5 to 10 m tall) trees and five to eight medium-sized trees (<5 m tall) that are in the reservoir area. Only the medium-sized trees will be inundated by the reservoir. Immediately upstream of the reservoir site, there is a dense patch of riparian vegetation with many tall trees (>5 m tall), and this riparian vegetation follows a narrow channel upstream into a fairly well-forested watershed. The Scoping Team observed high levels of bird activity at this site, likely due to the relatively intact riparian and forested areas. Other wildlife observed by community members include deer, rabbits, foxes, ocelots, paca, white-nosed coati, armadillo, iguana, and various birds. None of the species at this site is known to be on Honduras's list of threatened and endangered species.

The community normally cultivates corn, sorghum, beans, and cucumber and recently experimented with growing watermelon. They use limited pesticides and fertilizer (such as urea and 12-24-12). Crops in the region have not been productive this year because of drought. Without irrigation, the farmers water the crops by hand. With a more regular supply of water, the farmers would like to grow squash, watermelon, radish, tomatoes, and pumpkin. Community members supplement their diets by hunting wildlife in the hillsides above the reservoir site.

Although the group plans to use tilapia to manage mosquitos, they lack experience in this method of mosquito control. Thus technical assistance will be an essential component for success of this aspect of the project. Given the relatively well-forested watershed feeding the reservoir, community members did not express a concern about reforesting areas. However, given the important role of forests in watershed health, technical assistance in land use management is an important consideration for this site.

The group does not have well-developed policies or community norms for sharing water, and there are concerns that communities downstream might complain if sufficient water does not reach them during the rainy season. Maintenance of environmental flows to support downstream riparian vegetation is also an important consideration for the site. Furthermore, the reservoir spans the land of two separate owners, and continual coordination with both will be required for long-term success for sharing the water.

A unique consideration at the Altos de Estiquirin 2 site is the predominance of rocky substrate at the reservoir site, which will need to be removed. Outside material (e.g., clay or soil) might be required to complete construction of the reservoir.

EL TAMARINDO 2, NACAOME, VALLE

El Tamarindo 2 reservoir site will hold approximately 9,000 m^3 of water and provide irrigation to approximately five families with an average of four members per family. The proposed site for the reservoir is located in a shallow depression spanning an ephemeral stream. The owner manages about 50 ha of which only 2.5 ha are forested, and about 55 cattle graze the land. Cattle have significantly impacted the reservoir site; the soils are compacted, and the vegetation is largely grasses. There are about six mature trees dispersed throughout the reservoir site; development of the site will not cause loss of forested areas because the site itself and the surrounding hillsides already have been heavily affected by cattle and lack continuous tree cover. Cattle have significantly impacted the vegetation 50 to 100 m up- and downstream of the reservoir site, and riparian vegetation is thus absent in these areas. An established section of riparian vegetation exists more than 100 m below the reservoir site, and maintaining environmental flows to this area is an important consideration.

Wildlife has been observed in the vicinity of the proposed site; the group reported sighting squirrels, rabbits, armadillos, deer, skunk, and iguanas. With the exception of deer, all species are hunted for supplemental food. None of these species is currently on the Honduras threatened and endangered species list.

The primary beneficiaries of the proposed reservoir rent land from the owner and will cultivate fields downstream from the reservoir. They typically plant corn, sorghum, beans, and squash. However, given the significant drought in 2015, the farmers have been unable to successfully harvest their regular crops. The farmers expressed an interest in planting fruit trees, such as mango and cashew, to supplement their staple crops. Additionally, farmers are interested in reforestation, and tree species suggested by the groups included Guanacaste, mahogany, and acacia.

The social issues at this site are common to all the sites—the communities do not have well-organized norms or policies for sharing water, and methods for mosquito management are not well defined. Two homes are located within ½ km of the reservoir site, although the beneficiaries did not express concern about mosquito management.

As with most of the other sites, the reservoir will not affect forests in the immediate inundated area. Maintenance of environmental flows to support the downstream riparian vegetation is an important consideration for the site. Given the large number of cattle at the site, it will also be important to develop a management plan for cattle exclusion from the reservoir as well as from recently reforested plots.

CHAGUITE, NACAOME, VALLE

The Chaguite reservoir site encompasses a former clay excavation pit. The reservoir will store approximately 2,700 m^3 of water and will benefit about four families with about five members per family. Cattle grazing and clay extraction activities have significantly impacted the proposed reservoir site. A large shallow puddle persisted in the former clay excavation pit at the site, and the site has been used as a source of clay for the past 16 years. The owner reports, however, that excavation stopped about two years ago. Access to the site is an unimproved rocky road that requires a four-wheel drive vehicle.

The land conditions in the upper part of the micro-watershed are largely deforested and covered with small shrubs and grasses. Cattle graze the hillsides, and although there is little forest cover, shrubs and grasses stabilize the soil. There was no visual evidence of landslides on the surrounding hillsides. The stream originates in a saddle near the top of the micro-watershed and passes through marginal riparian vegetation lining a streambed filled with small rocks and pebbles. Grasses at the entrance to the reservoir site dominate the streambed, which is disrupted by the clay excavation pit. Dispersed throughout the reservoir site are about eight to 10 medium-sized trees (~3 to 4 m tall), which will be affected by the reservoir. No continuous forests, though, will be affected at the inundated site.

Downstream of the proposed reservoir and clay pit, the stream follows two distinct streambeds, which appear to change seasonally and/or depending on the volume of water flowing through the site. The streambed downstream is shallow and flat with drought-adapted shrubs and low trees in the riparian area. About 130 m downstream from the earthen dam site, the shrubby dry vegetation transitions to a narrow strip of trees about 5 to 8 m tall.

The existing pond attracts animals, and the farmer group reported observing coyotes, ocelots, and white-nosed coatis at the pond. Although the farmers in this group do not hunt very often, a long-term plan for wildlife management is still an important consideration for environmental management at the site. The Scoping Team observed small minnows in the remnant pond on-site. Community members reported that the fish seem to "appear" every time there is rain, suggesting a species well-adapted to flashy stream systems. Although the fish species was not positively identified, it is unlikely to be a species on Honduras's threatened and endangered species list.

The farmer group normally cultivates subsistence crops such as beans, corn, and sorghum, but like many farmers in the region they have experienced decreases in harvest quantity and quality due to drought. The reservoir project would enable these farmers to irrigate about 6 ha downstream of the reservoir site. With a more reliable water source, the farmers would like to plant cashew and mango trees to supplement their subsistence crops. There is an interest in reforestation efforts, but the group requires additional technical assistance for all stages of reforestation (e.g., species selection, tree nurseries, planting techniques, and maintenance).

As with most of the other sites, the reservoir will not impact forests at the inundation site, and the primary concerns at the site are related to training for reforestation; management of the reservoir to avoid rapid evapotranspiration; training in use of tilapia for mosquito management; and maintenance of environmental flows to support downstream riparian vegetation. In addition, the landowner has about 50 head of cattle that currently freely graze the property; developing a strategy to exclude the cattle from the reservoir is also an important consideration for the long-term structural integrity of the reservoir and maintenance of its water quality. Finally, given the history of clay excavation at the site, future excavation must be prohibited in order to protect the structural integrity of the site.

VUELTA AL CERRO 2, NAMASIGUE, CHOLUTECA

Vuelta al Cerro 2 is designed to hold 10,211 m^3 of water with a surface area of 4,928 m^2. The reservoir is tear-drop shaped, and the earthen dam will be placed at the widest section of the reservoir. Based on reports from the implementing partner, the reservoir site is comprised primarily of tall grasses and shrubs interspersed with trees. (Refer to Annex E for site-specific photos). The selected site for the reservoir is 4.3 acres in size at an elevation of 67 m above sea level with a slope of 10%. The property is owned by a community member and is currently utilized for cultivation of corn (~65%) and cattle grazing (~30%). The remaining 5% is characterized as shrubby vegetation, and there is one large tree located within the footprint of the proposed reservoir site. The closest house to the reservoir is located 50 m away above the reservoir; there are no houses located below the proposed reservoir site. The agricultural plots that will use water for irrigation are located within 100-200 m from the reservoir site. Currently, farmers cultivate corn, stargrass for hay bales, sorghum, and stover. With additional water resources, the producers would like to grow higher-value crops, such as ornamental plants, watermelon, sesame seeds, yucca, sweet potato, and fruits.

The site is considered ideal for the reservoir given its biophysical characteristics. Above the reservoir site, the stream channel is steep and narrow with uniformly tall banks; the soil is characterized by loamy clay to depths of 80-100 cm, which are ideal for construction of the earthen dam. The micro-watershed is fairly vegetated (~80%) and the community manages it to protect the water supply. The community does not hunt wildlife, but animals observed in the area include rabbits, migratory birds, armadillo, small rodents, and non-venomous snakes.

The proposed project would benefit 10 families; during a stakeholder engagement meeting, the beneficiaries identified the potential positive and negative impacts of the project. The stakeholder engagement emphasized the participation of all members of the family, with a specific focus on gender and benefits to women.

Positive benefits identified by the community include:

- Diversification of crops and an increase in production via use of the water in the reservoir
- Conservation and expansion of forested areas in the recharge zone and around the reservoir site to improve capture of water
- A permanent source of water for uses other than irrigation
- Cultivate fish in the reservoir as another source of food protein
- Reduce flooding in agricultural lands
- Reduce the risk of crop loss in winter and summer
- Improve market access
- Potentially create a tourist attraction if biodiversity increases

The community also identified possible negative impacts of the project including:

- Poor construction of the reservoirs that could results in failure of the earthen dam and cause harm to people, their property, and/or the environment
- The reservoirs may become a mosquito breeding area
- There could be conflicts from other downstream users because of the lack of water
- Inappropriate use of agro-chemicals in the irrigated parcels could contaminate the streams below the parcels
- Public safety at the reservoir to avoid drownings or other safety issues
- Landslides and erosion in the upper part of the watershed due to lack of vegetation

The women's group identified several potential positive impacts of the proposed project, including greater diversification of crops; increased production of crops; improving the family's income and sources of employment that could help reduce migration to other areas for work. Better integration among community organizations as well as increased participation by women and children, which will strengthen the families and the community. In addition, creating the reservoir could strengthen organizational ties via establishment of the "caja rural", association with the women's campesina group, and formation of an association of irrigators.

As with most of the other sites, the reservoir will not impact forests at the inundation site, and the primary concerns at the site are related to training for reforestation; management of the reservoir to avoid rapid evapotranspiration; and training in use of tilapia for mosquito management. Maintenance of environmental flows to support downstream riparian vegetation is also an important consideration for the site.

3.2 NO-ACTION ALTERNATIVE

The Corredor Seco of Honduras is critically stressed by poverty, drought, and increasing climate variability. Under normal conditions, traditional agricultural practices in this area depend on predictable rainfall for either rain-fed agriculture or flood irrigation. The farmers typically only cultivate during the rainy season, often using slash and burn methods to clear land in order to cultivate basic grains (corn, sorghum, and beans). As a result of El Niño in the last few years, the region has suffered severe changes that threaten agricultural production and productivity, as well as the food security of the families of small-scale farmers who lack resources and are located in marginal hillside areas. In coming years, similar conditions experienced under El Niño are anticipated as the effects of climate change become more apparent in the region. If drought conditions persist, suitable land for rain-fed agriculture could decrease considerably as a result of loss of soil moisture (IDB 2014). The No Action alternative preserves the status quo—rain-fed agriculture, occasionally supplemented by flood irrigation—thereby restricting opportunities to enhance resilience of the region to climate change and provide potential improvements in food security.

Flood irrigation, also known as surface irrigation, is one of the most common traditional methods of crop irrigation. With this method, farmers transport water to the field, either by hand or using a pump, and the water flows freely among the cultivated crops (USGS 2015). In its lowest-technology form, farmers use buckets to transport water from rivers, lakes, or other bodies of water so that it flows among the crops, eventually creating pools of water in the ploughed valleys of the field. This is the method often preferred by lower-income farmers since it is relatively low-cost, and it allows them water usage during the sporadic rainy seasons. More modern techniques use pumps and pipes but still rely on the basic principal of flooding fields to move water (Perlman 2015).

Flood irrigation is only an option when water is available, limiting crop production throughout the year; specifically, farmers are unable to cultivate crops in dry seasons or periods of drought. Additionally, fields must be located close to a water source, further limiting its widespread application. Flooding also has a very high rate of evaporation and run-off, which can pose a significant problem in areas with low rainfall such as the Corridor Seco (Pearlman 2015).

Flood irrigation relies upon gravity to distribute water throughout a site. If a site is not level, water will not reach some areas of the plot. Although flood irrigation is simple to implement, it increases the level of effort for farmers since flooding encourages weed growth and encourages pests. Other disadvantages are that it leads to rapid soil degradation and inefficient use of water (USGS 2015), and it commonly leads to waterlogging and salinization of soils due to poor drainage, over-irrigation, and leakage of irrigation canals. Once the soil is saturated with water, the water will draw up salts from lower in the soil table, disrupting plant root growth. In drier areas, this poses a particular problem because there is not much rainfall to leach away the accumulating salts (FAO 1997).

The simplicity of flood irrigation installation masks some underlying challenges, including inefficient water use and inadequate soil infiltration. Infiltration of water is influenced by soil type, and the properties of soil may vary within a field, which affects infiltration rates and results in uneven irrigation. Furthermore, because the systems are relatively low tech, farmers have little control over the intensity and frequency of irrigation, which is inefficient. Light and frequent watering, which is the preferred method for many crops and soil types, may be impossible with this method (FAO 1989).

Flood irrigation also has direct impacts on the surrounding environment. Even in highly developed countries, "flood irrigation practices generally don't incorporate methods of preventing runoff from returning to the watercourse; thus a deterioration in water quality is inevitable" (Otago 2006). Flood irrigation often increases sedimentation and water temperature, which may adversely affect aquatic life and encourage the growth of pathogens (Otago 2006).

Flood irrigation is widely used in Central America, especially in sugar cane fields. However, it frequently contaminates surface waters that come into contact with trash, waste, and cattle pastures. A study in Mexico indicated that water impounded by dams for flood irrigation may be contaminated with pathogens and microscopic parasites, further compromising the edibility of the produce, especially when consumed raw (Matthews 2014). Because the stagnant pools of water inherent to flood irrigation are often a breeding ground for diseases and pathogens, particularly when fields are poorly drained, flooded fields can become an incubator for disease and parasites. Mosquito-borne pathogens, particularly malaria, pose especially significant risks to farmers employing flood irrigation (FAO 1997).

Despite its significant drawbacks, many farmers will likely continue to use flood irrigation because it is simple and low-cost. Flood irrigation has been practiced for generations, and most farmers likely have at least some rudimentary understanding of this method and are comfortable employing it (FAO 1989). Unlike sprinkler systems, flood irrigation is not affected by changes in wind. Unlike drip irrigation systems, flood irrigation is not compromised by the deposit of sediments and small debris in irrigation pipes or hardware. Further, flood irrigation requires "minimal capital investment" to develop, and farmers can easily build the infrastructure with readily available materials and the use of gravity rather than pumps to move water. However, given the extended dry season and increasingly unpredictable rainfall (SERNA 2014) in Southern Honduras, this method is not ideal for improving agricultural yields due to inefficient use of water.

Greater yields, increased productivity per unit of input, reduced risk, and increased market access all depend on a capital investment to enhance resiliency to drought and other climate variability. The No Action Alternative—rain-fed agriculture, occasionally supplemented by flood irrigation—forgoes the construction of the proposed diversion and irrigation schemes by USAID. Absent finance to invest in their own infrastructure, farmers will remain vulnerable to droughts, unpredictable rainfall, and climate change. They will also remain vulnerable to food shortages and will be limited to crop production in the rainy season only, further affecting food security and poverty rates.

3.3 PUMP IRRIGATION FROM GROUND WATER, DRILLED OR TRADITIONAL WELLS

Use of groundwater for agriculture is very limited in Central America, including Honduras. The region primarily relies upon rainfall and/or gravity (or flood) irrigation for agriculture. Annual rainfall can be unpredictable, creating insecurity in food supply for smallholder farmers. Thus, some might consider groundwater wells a more reliable source of water for irrigation. In Honduras, the principal uses of all water (surface and groundwater) are for domestic purposes, industrial processes, agriculture, and hydroelectricity. Agricultural use is the primary demand for surface water in Honduras (GWP 2015); the departments of Yolo, Choluteca, and Cortes primarily use sprinkler or drip irrigation to cultivate bananas, melon, and sugarcane (Ballestero, Reyes, Astorga, 2007). Of these regions, the Choluteca department utilizes the most groundwater for irrigation. The total annual demand for water in Honduras is estimated at 1,900 hm3/year, of which only

10 percent is supplied by groundwater. Only 6 percent of the cultivated areas in Honduras, though, are equipped for irrigation of any kind (FAO AQUASTAT 2015).

Although some might propose using groundwater from wells to irrigate cultivated lands in the departments of Choluteca and Valle, very little comprehensive data exist for groundwater resources and aquifer volume and extent in Central America, which presents significant challenges for use and management of groundwater resources (Ballestero, Reyes, and Astorga, 2007). A limited study of groundwater in Choluteca found that the hydrogeology of the region is complex due to fractures related to a fault line in the underlying bedrock. The study's results did not clearly indicate whether groundwater could flow across an existing fault line. Groundwater in the region occurs in the bedrock and alluvium, although the study results indicated marginal flow from test wells (from 80-155 ft below ground surface) in both the bedrock and the alluvium (USAID 2002). Additional test sites in the Choluteca flood plain indicated the alluvial deposits there do not yield sufficient supplies for municipal purposes and would not be an adequate source for agricultural purposes. The limited data from the region indicate a high level of uncertainty related to groundwater availability. If this alternative were pursued, extensive hydrogeological studies of each proposed site would need to be undertaken to assure sufficient flow for irrigation purposes.

The lack of comprehensive groundwater studies in the region could also make drilling for water time-consuming and cost-prohibitive. Average costs for drilling a well in the region are as follows:

- US $2,000 for conductivity testing to identify potential drill sites
- US $28/ft for a 6-10" diameter well
- US $2,000 for additional costs for equipment, gauging, and labor
- US $5,000 for a pump

Average depth of a well in the region is 300 feet. A 6" diameter well would cost a community $7,500 to drill plus the additional costs outlined above. [1] Given the low socio-economic status of the targeted communities (see Section 4.1), the costs of drilling a well to benefit a single user or just a few users would be prohibitive compared to $15,000 to construct a reservoir that would benefit multiple families.

There are several sources of potential groundwater contamination in the area, including agriculture, livestock, and human waste from inadequate sanitary infrastructure. Nitrates and coliform bacteria were identified in groundwater sources. In Choluteca, the issues with groundwater quality include contamination of the aquifer, specifically related to hardness; salinity; and presence of agrochemicals, heavy metals, and sulfates. According to the Global Water Project, the primary issues with water quality are tied to overexploitation, conventional agricultural techniques, expansion of the agricultural frontier, increased pressure on existing resources, and exploitation of forest resources (GWP, 2011). Additionally, many of the existing wells lack adequate protection at the surface to prevent contamination, which could migrate to groundwater sources. Finally, much of the groundwater in Central America is extremely vulnerable to pollution because of the structure of the aquifers, which are covered by fractured or permeable materials and are generally quite shallow with low flows (USAID, 2002)[2].

Smallholder farmers commonly use surface water, groundwater, or small rainwater storage tanks for individual plots. Pumping water from wells that provide a consistent supply of water could benefit many farmers, by permitting a substantial increase in crop diversification and yield and increased number of

[1] Maquinarias del Pacifico located in Choluteca provided an indicative cost estimate for drilling 6" and 8" diameter wells in the Namasigue department based on their experience in the region.

[2] Groundwater Resources Monitoring Report and Management Plan: Limon de la Cerca, Honduras. 2002. http://pdf.usaid.gov/pdf_docs/Pnacu597.pdf

harvests per year, leading to increased incomes. However, the cost of electricity to pump water is substantial, and Honduras has had a long and unsuccessful history of irrigation through the use of inefficiently powered pumps. For example, the MoA had various programs that donated irrigation pumps to farmers who later abandoned use of the pumps after two to three years due to the higher costs for operation and maintenance. Additionally, the pumps-to-tanks alternative does not incentivize farmers to scale-up production at a community level. Less than 10 percent of Honduras's water needs are met via groundwater, and groundwater availability and recharge rates vary throughout the country. Thus, any plans for boreholes or other wells would need to consider the regionally specific groundwater conditions as well as the cost of drilling wells to the smallholder farmer groups.

3.4 WATER HARVESTING WITH SPRINKLER TECHNOLOGY

Another alternative to the proposed action is to combine the micro-reservoirs with sprinkler irrigation rather than ultra-low drip irrigation. Center pivot sprinklers with low-pressure spray and low-pressure applicators can be very useful for irrigating uniformly. Sprinkler systems may get clogged less frequently than drip irrigation systems. However, sprinkler systems lose efficiency on oddly shaped fields and/or when the center pivots cannot rotate in a full circle (Colaizzi et al 2006). The efficiency of spray application via sprinklers is highly dependent on the type of device, tillage technique (furrows generally assist in water conservation), and soil type. For example, grain yields and water use efficiency can be significantly reduced when tillage techniques and irrigation devices vary (Colaizzi et al 2006).

Sprinkler systems often require less maintenance than drip irrigation systems, and identification of problems can be more straightforward. Furthermore, sprinkler system spray patterns are adjustable, can be easily automated, may be used for chemigation and fertigation, and may be adapted to a wide range of soil and topographic conditions (Fipps G and FJ Dainello 2009). However, sprinkler systems are usually less efficient than drip irrigation systems with respect to water use (Peters 2009).

Although water harvesting could be combined with sprinkler technology, farmers in the Corredor Seco would need approximately twice as many reservoirs to irrigate with sprinklers as they would need to irrigate with drip systems, due to less efficient water use (Pers. Comm. Global Communities). Sprinkler systems generally operate at a much higher pressure than drip systems—45-70 psi versus 8-20 psi—which translates to higher pumping power and energy requirements for sprinkler systems (Peters 2009). Maintenance costs are also higher, since sprinkler system pumps have to be serviced and replaced on a regular basis. The efficiency and potential for evaporation are important considerations given the recurrent drought conditions, limited water supply, and arid climate in the Corredor Seco.

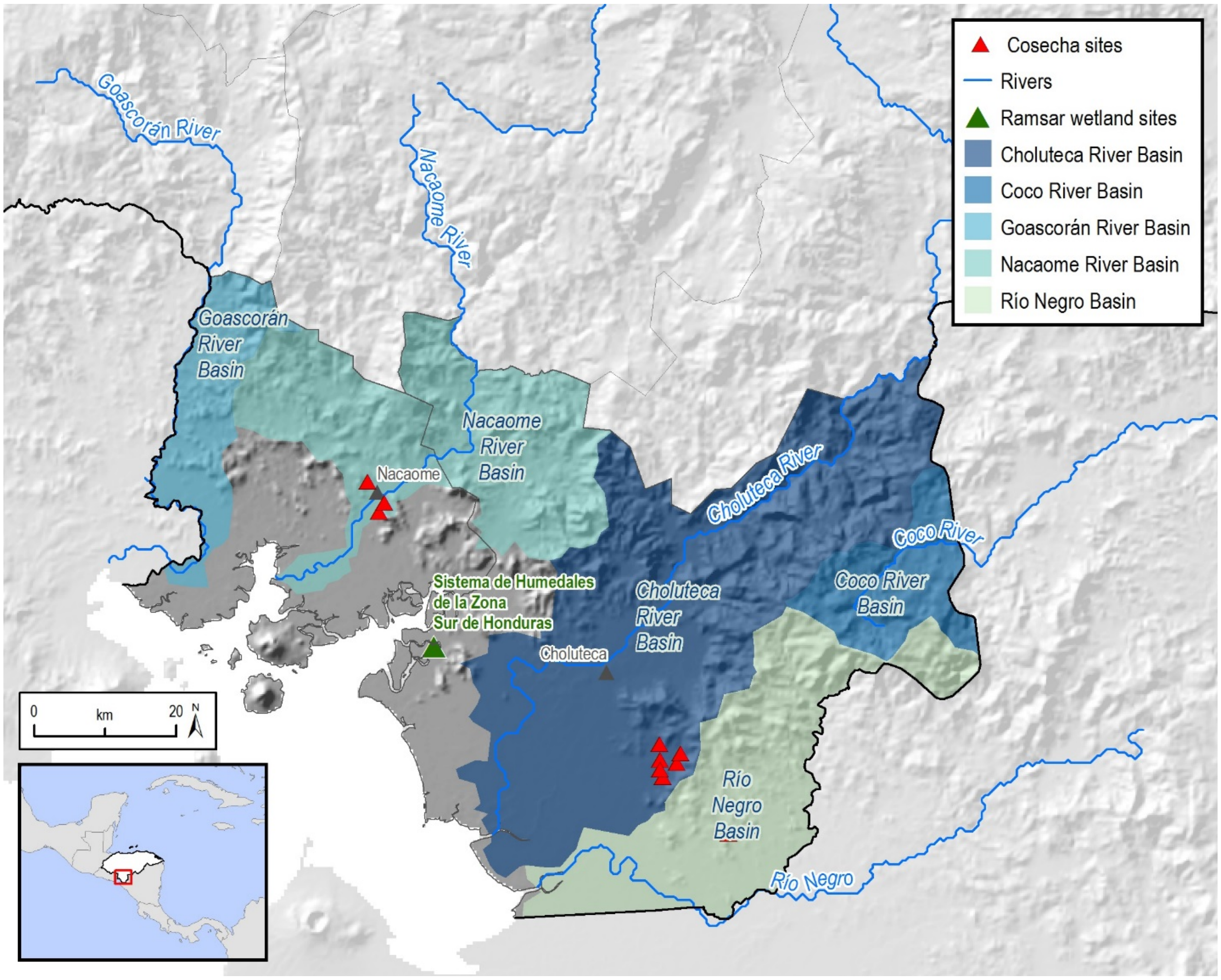
4.0 AFFECTED ENVIRONMENT

This section describes the environment affected by the proposed project at the 10 communities and micro-watersheds in the Valle and Choluteca Departments of Southern Honduras. For each reservoir, the boundary of the affected environment includes:

1. The micro-watershed area and associated ecosystems providing water for irrigation
2. The reservoir, including any areas disturbed during construction
3. The irrigated lands
4. Drainage areas, including the ephemeral streams abstracted by the reservoir, riparian zones, and any other areas hydrologically connected to the stream

The volume of each reservoir ranges from 4,295 m^3 to 17,666 m^3, and water from each reservoir will be used to irrigate fields located below each proposed reservoir site (Figure 3).

Figure 3. Watersheds in Valle and Choluteca



Unless otherwise noted, the following sections describing the affected environmental are largely taken from the *Scoping Statement for Cosecha: A Rainwater Harvesting Project in Southern Honduras* (October 2015).

4.1 SOCIOECONOMIC CHARACTERISTICS

This section describes the social characteristics (population size, age distribution, ethnicity, gender, socioeconomic characteristics, cultural characteristics, public health status, etc.) within the approximate boundaries of the *Affected Environment*; it uses the Scoping Statement as its foundation but provides more detail and/or updated data, as available.

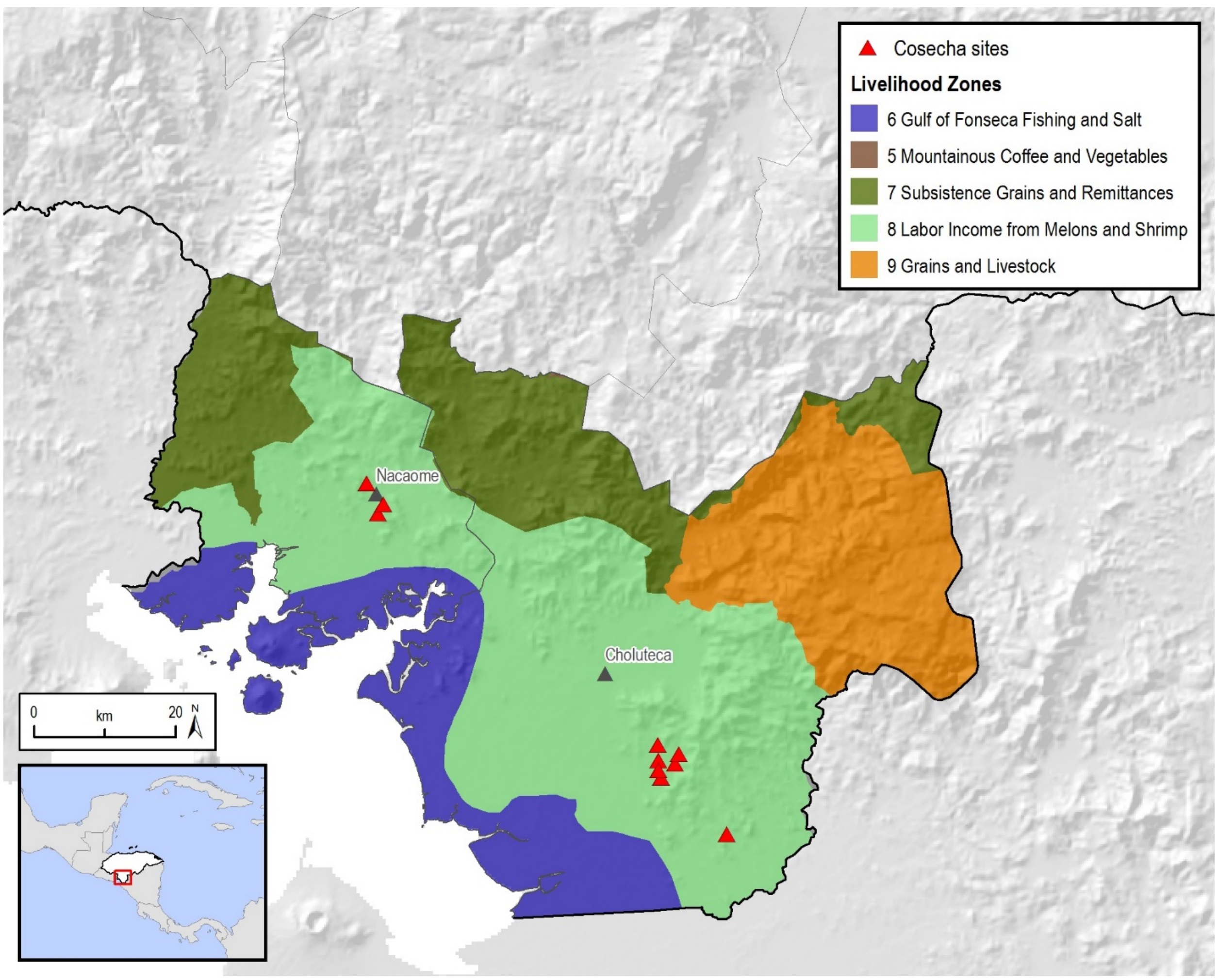
4.1.1 POPULATION

Honduras's estimated population is 8.6 million, comprised predominantly (90 percent) by Mestizos (mixed Amerindian and white), 7 percent Amerindians, 2 percent Afro-descendants, and 1 percent of people of European origin (CIA, 2014). These groups can be further divided into seven different ethnic groups: (1) Spanish-speaking Latinos, (2) English-speaking Criollos, (3) Garifuna (Afro-Antilleans composed of four indigenous groups); (4) Chorti (Mayan descendants), (5) Macro Chibcha (composed of four indigenous groups), (6) Uto Azteca or Nahua, and (7) Hokan-Sioux or Tolupan (Hansen and Flórez, 2008). In 2014, the population growth rate was about 2 percent per year, which translates to an average of three children per woman, with birth rates higher in rural areas. In 2011, 52 percent of the country lived in urban areas, with urbanization rates reaching over 3 percent (CIA, 2014). In 2013, the combined population of the departments of Valle and Choluteca was 612,129 (Table 9).

The vast majority of urbanization in Honduras is due to a geographic shift in employment opportunities, primarily on or near the Caribbean coast and Tegucigalpa. Unemployment is a larger issue in these regions, which are under constant pressure from the influx of new laborers. The rural population of Honduras has a 72 percent poverty rate, of which 16 percent are extremely poor (<$1.81/day). For the urban populations, 60 percent live in poverty, 54 percent of which live in extreme poverty. Other departments experiencing a rising population growth rate are La Ceiba on the Caribbean coast and El Progreso in the agricultural valley of the Ulua River. This population shift has caused negative environmental impacts as a result of increased depletion of natural resources and inadequate infrastructure (Tabora et al., 2011).

In 2013, there were approximately 3.5 million people in Honduras' workforce (14 percent in agriculture, 28 percent in industry, 58 percent in services). The primary agricultural products in Honduras are bananas, coffee, citrus, corn, African palm, beef, timber, shrimp, tilapia, and lobster (CIA, 2014). In the project area, the primary livelihood is labor income from producing melons and shrimp; the August 2015 field visits indicated that subsistence agriculture remains an important income source (Figure 4).

Figure 4. Livelihood Zones in Southern Honduras



The combined 2013 population of Choluteca and Valle (612,129) represents approximately 8 percent of the national population. In particular, the Choluteca Department has the highest population, which represents 60 percent of the region's total, and several of the municipalities where the proposed rainwater harvesting program will occur represent a large portion of the region's population (Table 10).

Table 9 Population by Department for the proposed project

DEPARTMENT	POPULATION (2001)	POPULATION (2013)
Choluteca	390,805	437,618
Valle	151,841	174,511
Total	542,646	612,129

Source: INE. XVII Censo Poblacional y VI Censo de Vivienda. Información Comparativa entre Censos. 2014

Table 10 Ten municipalities that, taken together, comprise more than half of the total population in Southern Honduras

MUNICIPALITY	POPULATION*
Choluteca	120,791
Nacaome**	46,780
Triunfo	35,830
San Lorenzo	28,586
Marcovia	37,824
Namasigue**	25,144
Concepción de María**	24,406
Pespire	23,332
El Corpus**	21,856
San Marcos de Colón	20,493
Total	385,042 (63%)

* Population by department in relation to total population of Southern Honduras
** 4 of the 5 municipalities where the proposed project will be implemented

The ratio of men to women in Southern Honduras is about equal at the municipal levels; approximately 62-76% of the population in Southern Honduras is literate; and approximately 54-80% have access to water (Table 11).

Table 11 Socio-demographic Characteristics in the Southern Region by Principal Municipality

MUNICIPALITY	POPULATION	WOMEN	MEN	% LITERACY	HDI	% ACCESS TO WATER
Apacilagua	8,954	4,377	4,577	63.5	0.542	54.5
Concepcion de Maria	24,406	12,009	12,397	62.1	0.534	61.8
El Corpus	21,856	10,761	11,095	65.8	0.564	52.3
Namasigue	25,144	12,391	12,753	65.6	0.581	73.4
Nacaome	46,780	23,738	23,042	76.2	0.628	79.7

Sources: INE, National Census on Population and Housing 2001; UNDP: Human Development Report 2003; UNAT, Ministry of the Presidency

4.1.2 POVERTY INDICES

The United Nations Development Program categorizes Honduras' Human Development Index (HDI) as medium. Poverty, social inequality, and uneven access to social services and economic opportunities have contributed to the stagnation of Honduras's HDI. Honduras has gradually improved its HDI, and in 2014 its HDI reached 0.617, ranking it 129 out of 187 countries. However, since 2012 the country's HDI has decreased slightly likely due to natural disasters, security concerns, and an unstable political climate (UNDP, 2013). Honduras ranks third among Latin American countries for education inequality, an indicator of income inequality, and has not improved literacy rates or achieved school enrollment rates greater than 53 percent.

Life expectancy in Honduras (73.8 years at birth) has slowly improved since 1980 (UNDP HDI, 2014), but it remains low compared to other countries in the region largely due to lack of accessible health coverage and quality. In 2004, 79 percent of children between 3 and 59 months old suffered from moderate malnutrition; 48 percent suffered from severe malnutrition. More than 29 percent of the total population did not have access to quality water. Economic reform and policy measures taken by various governments did not result in substantial improvements; thus poverty, unemployment, social inequality, low quality of jobs, and lack of basic infrastructure persist in the country.

- Approximately 50 percent of the people in Honduras are adolescents under age 18. An estimated 54 percent live in rural areas, and 51 percent are female. It is estimated that in 2015, 60 percent of the population will live in urban areas.
- The average number of persons per household is five, a number that is slightly larger in rural areas.
- The population of children between 5 and 14 years of age is 1,750,000. About 360,000 children under age 5 are chronically malnourished, and 20 percent of people over the age of 15 cannot read or write. Of adults older than 60 (7 percent of the population), 49 percent cannot read or write.

According to the UNDP HDI (2014), the migration rate is -1.2 per 1000 people.

The weak economy in the southern region, characterized by the agricultural sector and a subsistence economy, has caused migration to other areas of the country with greater employment opportunities. The Choluteca region has a Human Development Index (HDI) of 0.600, lower than the national HDI of 0.617. Alianza has the highest HDI in the region (0.671), and San Lucas has the lowest (0.483). Migration from the south is directed to the capital, Tegucigalpa, and the Valle de Sula zone in the north, which has the largest industrial area in the country, principally in the San Pedro Sula, Choloma, Villanueva, and La Lima municipalities of the Cortes department.

The historical rate of migration has a direct impact on regional development, including:

- Loss of human resources necessary to support development in the region;
- Abandonment of rural productive base;
- Increasing dependence on remittances from family members who live and work elsewhere;
- Increased social vulnerability; and
- Drain of intellect and talent from the region towards other regions and/or countries as a result of lack of internal opportunities.

Motivated by job instability, low salaries, low education levels, low agricultural production, deficient infrastructure, lack of employment opportunities, and lack of access to land, migration from Southern Honduras can be seen as forced migration.

Illiteracy also impacts economic development. About 68 percent of the total population in the region has full literacy, compared to the national rate of 85 percent[3] (rates for individual municipalities are listed in Table 11). The literacy rate by municipality varies from 52 percent in Liure to 81 percent in the Caridad and San Lorenzo municipalities in the Valle department.

Water availability further impacts the economic potential of the region. The southern region typically has a marked seasonal drought for six months out of the year. In general, the weather is warm, and average temperatures fluctuate between 27°C and 38°C. Unpredictable precipitation coupled with a steady demand for water for both agricultural production and household usage impacts economic development in the region. About 67 percent of homes have potable water, and these conditions have resulted in deteriorating quality of life for a large part of the population, especially in regions where weak management and administration of services cannot provide adequate quality and quantity of water.

4.1.3 POVERTY SITUATION IN MUNICIPALITIES IN SOUTHERN HONDURAS

Southern Honduras has higher rates of poverty than other areas of the country. In Southern Honduras, 76 percent of the population on average lives below the poverty level (rates for individual municipalities are listed in Table 12). In the rest of Honduras, 60 percent of the population lives below the poverty line, and in the southern region, municipalities are equally poor as the poorest municipalities found in other regions. Poverty is measured based on the ability of a family to purchase a basket of basic goods, which includes food, rent, and education for a family of five; the average annual cost for the basket of goods is about US$643/year.[4] UNICEF defines extreme poverty in Honduras as living on less than US$1.25/day.[5]

Table 12 Southern Region Poverty in Terms of Unsatisfied Basic Needs

MUNICIPALITY	POPULATION (2001)	% IN POVERTY	% IN RELATIVE POVERTY	% IN EXTREME POVERTY
Apacilagua	8,954	14	23	63
Concepcion de Maria	24,406	29	34	37
El Corpus	21,856	22	33	45
Namasigue	25,144	24	30	46
Nacaome	46,780	19	29	52

Source: INF, National Census on Housing and Population 2001

4.2 BASIC INFRASTRUCTURE IN MUNICIPALITIES

Infrastructure in Southern Honduras varies in quality and ability to deliver services outside of population centers. Access to basic infrastructure, such as roads, electricity, and potable water, varies among the targeted communities. Housing is generally basic and constructed of adobe and tile and/or wood or concrete block. Poor quality of construction materials, lack of maintenance, natural disasters in the region, and/or aging buildings all contribute to the poor infrastructure in the region.

[3] UNDP- HDI Honduras Country Profile. http://hdr.undp.org/en/countries/profiles/HND

[4] La pobreza en Honduras. http://www.resistenciahonduras.net/index.php?option=com_content&view=article&id=1339:la-pobreza-en-honduras&Itemid=249

[5] ODM1. Eradicar la pobreza y el hambre. http://www.unicef.org/honduras/ODM1.pdf

4.2.1 ROADWAYS

The main road to Southern Honduras is in good condition but historically has not been regularly maintained, and secondary and tertiary roads receive little maintenance. The roads are generally constructed with inadequate specifications for tread, culverts, and sewage. Ultimately, this results in rapid deterioration of the roads, increasing sediment flow to waterways. Furthermore, poor construction causes the roads to become impassable in the rainy season, which may limit access to some sites in the rainy season. The access roads to the proposed sites are generally unmaintained dirt roads, with the exception of a few sites, which are located near main arterials.

4.2.2 HOUSING

Most houses are constructed with adobe and tile, have one or two rooms with an average of four to five people per room, and have little sanitation. Approximately 59 percent of homes were deemed inadequate for sanitation by Foro Social para la Deuda Externa de Honduras (FOSDEH), and in 80 percent of homes, firewood is used to cook all meals. The construction materials of the houses are mostly made of mud and adobe with tile roofs, and some houses—located mainly in the urban part of municipalities—are built of brick block with asbestos roofs.

4.2.3 NETWORK OF POTABLE WATER

In the Choluteca region in Southern Honduras, water does not meet standards for consumption. According to bacterial analysis studies carried out by Public Health, Municipal Environment Units, and the USAID Forest and Water Project, watersheds that supply areas surrounding Guanacaure Peak in Choluteca were found to have fecal contamination in the main water system. Thus, water is treated with HTH (calcium hypochlorite) for consumption. Approximately 44 percent of households within the region are without potable drinking water; the watersheds and the associated communities are listed in Table 13.

Table 13 Populations that Use Hydrological Resources in the Choluteca Region

WATERSHED	COMMUNITIES ASSOCIATED WITH WATERSHED	MUNICIPALITY
Los Amates	Choluteca, Tablones Arriba, La Fortuna, Los Tubos, Las Lomas, El Carreto, Los Chagüites.	Choluteca, Santa Ana de Yusguare and El Corpus
Seca	Namacigüe Centro, Santa Isabel, La Danta , San Agustín, La Constancia, El Carrizal, La Montaña	Namasigüe and El Corpus
Santa Teresa	Bijagual, Las Playitas, Los Cocos, El Tríunfo and Matapalos	El Corpus and El Tríunfo
Tierra Blanca	La Fortunita, La Tajeada, Tierra Blanca, Jocomico, Las Marías, Tipurín, Espabeles	El Corpus, Santa Ana de Yusguare and Namasigüe
San Juan	San Juan Arriba, Linda Vista, San Juan Abajo	El Corpus
Tiscagua	Agua Fría, El Aguaje, Pueblito, Quebrachito, La Cuchilla and Tiscagua	El Corpus

Source: UMA Choluteca, PBA Diagnostic

4.2.4 SOLID WASTE MANAGEMENT

Solid waste is managed at the household level and is generally burned or buried. There is not a solid waste collection system in the rural areas. Inadequate waste management is due mainly to a lack of financial and managerial capacity of municipalities to supply the services and poor application of standards and laws to control waste disposal.

Unmanaged waste can impact the health and quality of life of those in direct contact with uncollected solid waste and informal dumps in streets and ravines. The sites might contain hazardous waste, which is a threat to human health.

4.2.5 SEWAGE SANITATION

Wastewater management infrastructure, specifically septic tanks and latrines, is available in most urban parts of municipalities. However, the majority of rural residences manage human waste with latrines that are constructed with the support of NGOs, public health agencies, and the municipalities.

4.2.6 EDUCATION

The majority of the population has limited access to education and relies on agriculture for economic livelihood. Furthermore, the lack of qualified instructors impacts the quality of education, and up to four grade levels will often be a part of the same class. According to the PMA Choluteca Diagnostic study, 23 percent of children ages 7 to 12 either do not attend school or are often absent as a result of working to contribute to family income. Though the number of schools that exist in the Choluteca region (22) may be sufficient, they lack sufficient staff and teaching materials; the buildings are often inadequate; and they often lack electricity.

4.2.7 ACCESS TO HEALTH SERVICES

There are four Rural Health Centers (CESAR) in the project area, located in the Agua Fría, Los Cocos, La Fortuna, and Playitas communities in the El Corpus municipality. These centers serve approximately 19 communities. There are two CESARs, located in Tablones Arriba and La Tajeada communities, which serve the Santa Ana de Yusguare municipality. In the Namasigüe municipality, the majority of residents of the Santa Isabel, San Agustín, La Constancia, and La Danta communities go to the CESAR of San Rafael Arriba, and others go to CESAMO of Namasigüe Center.

4.3 PHYSICAL AND ENVIRONMENTAL CHARACTERISTICS

Honduras is the second largest Central American country (after Nicaragua) and is located at the widest part of the isthmus of Central America (Figure 2). The country's total area is 112,500 km² and includes borders with Guatemala (250 km), Nicaragua (900 km), and El Salvador (340km). The country is also bordered to the south by the Gulf of Fonseca between El Salvador and Nicaragua and the Caribbean Sea to the north (CIA, 2014).

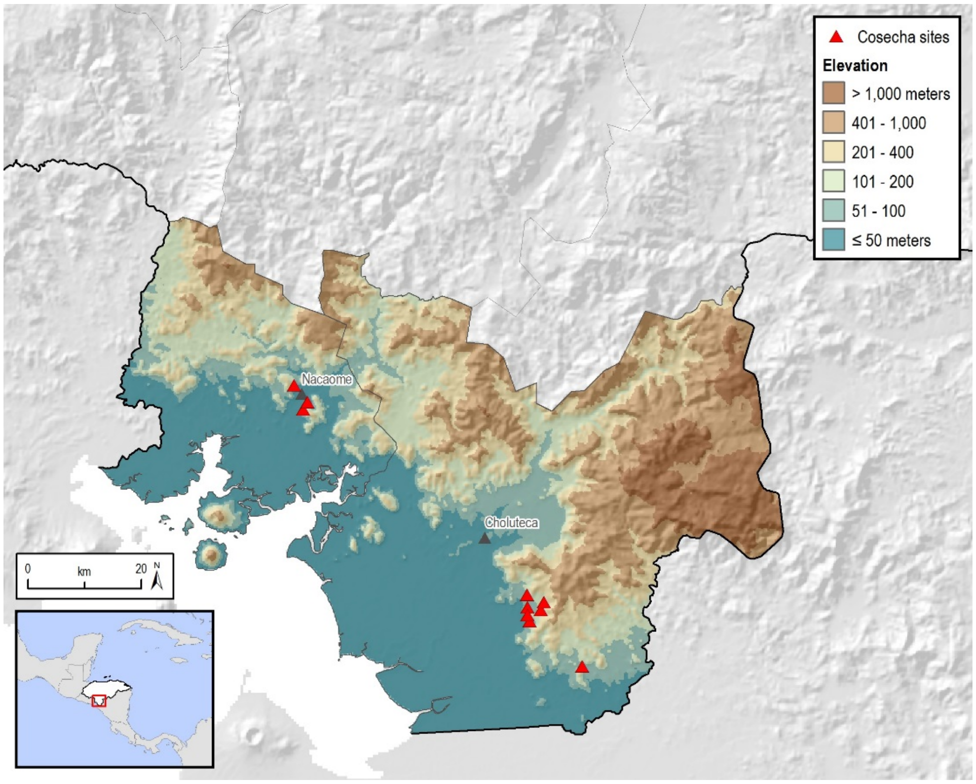
4.3.1 TOPOGRAPHY

Honduras has three distinct topographical regions: (1) the interior highlands, (2) the Caribbean lowlands, which are characterized by alluvial plains in the north, and (3) the Pacific lowlands bordering the Fonseca Gulf.

The interior highlands are mostly mountainous and cover 82 percent of the country's terrain. This region is formed by the Central, Northern, and Southern mountain chains. The northern Caribbean lowland covers 16 percent of the country's territory and consists of river valleys and coastal plains. This region is hot and humid, receiving about 2,000 mm/yr rainfall with temperatures reaching 24°C. To the east and west, the Caribbean lowlands contain broad river valleys.

The watersheds in Southern Honduras are steep, with an average slope of 17 percent and a land cover ratio of less than 50 percent, indicating that most of the lands in these watersheds have been cleared of natural vegetation and converted to croplands or pastures (TetraTech ARC 2013).

Figure 5. Elevation of Valle and Choluteca



The country's smallest topographical region, the Pacific lowland in the south, includes the coastal plains and the Gulf of Fonseca and covers 2 percent of the country's territory. The coastal plain is mostly flat and composed of alluvial soils washed from the mountains, creating swampy terrain near the gulf. The Gulf of Fonseca includes Zacata Grande Island, Tiger Island, and numerous smaller islands.

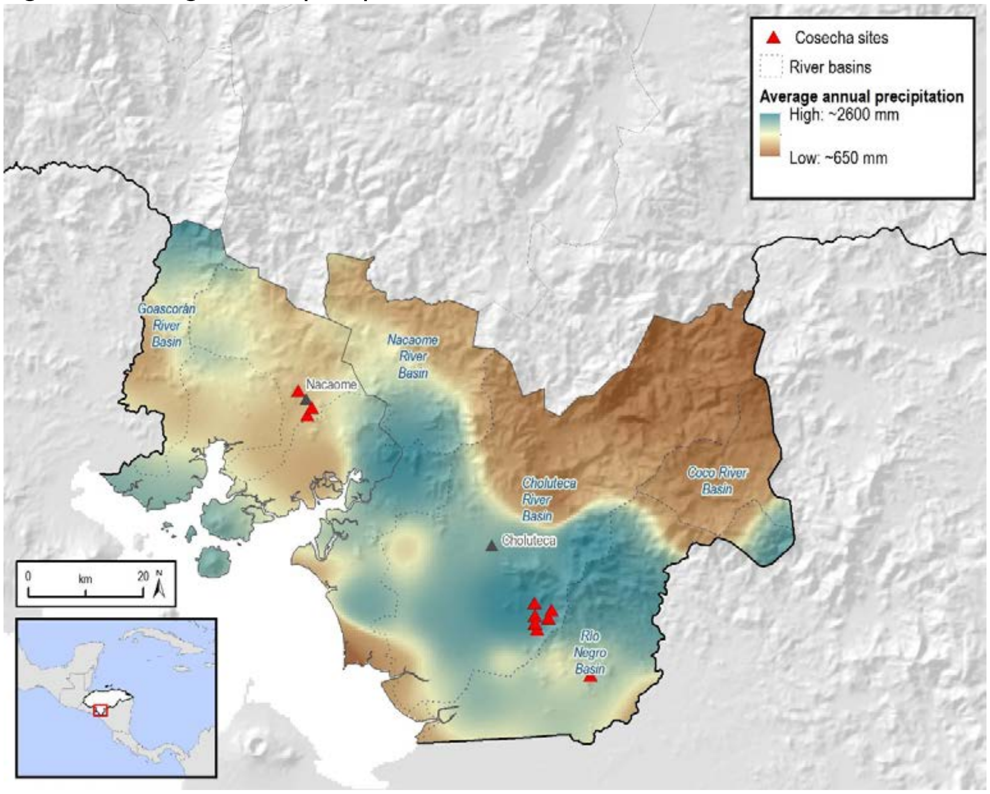
4.3.2 CLIMATE

Honduras has three main climatic regions that are associated with the topographic regions. The Caribbean lowlands have a tropical wet climate with consistently high temperatures and humidity and evenly distributed annual rainfall. The Pacific lowlands have a tropical wet climate with high temperatures and a distinct dry season (November through April). The interior highlands have a distinct dry season November through April with cooler temperatures as elevation increases.

Temperatures in the tropics vary primarily with elevation. Areas described as "hot zones" are located below 1,000 m elevation, temperate zones are located between 1,000 and 2,000 m, and cold zones are above 2,000 m. The Caribbean and Pacific lowlands are "tierra caliente" with daytime highs averaging between 28°C and 32°C and higher humidity during the rainy season. The interior highlands range from moderate to cold temperatures with an average high temperature during the coldest month (January) between 25°C and 30°C. In the cold zone, temperatures typically fall near freezing at night.

Overall, the country's coldest month is December, when temperatures vary between 8°C in the highlands and 28°C in the Pacific lowlands. The country's hottest month is April, with temperatures varying between 10°C in the highlands and 31°C in the Pacific lowlands. Annual precipitation in Honduras is extremely variable across regions, between 900 and 3,300 mm (Servicio Meteorológico Nacional, 2014). The Valle department receives less precipitation than Choluteca (Figure 6), and the entire region is particularly susceptible to climate change and drier conditions associated with El Nino. Usually there are two rainy seasons per year, the "primera" from May to August and the "postrera" from September to December. January to April is usually a dry period (Merrill, 1995).

Figure 6. Average annual precipitation in Valle and Choluteca



4.3.3 HONDURAN ECOREGIONS

There are seven ecoregions in Honduras (Churchill & Dobrowolski, 2002), including two types of mangrove forest and five terrestrial types of forest. Caribbean and Pacific Mangroves stretch over 2,500 km^2, occupying all of the country's coasts. They serve as a buffer between marine and terrestrial regions by protecting the marine environment from terrestrial sediment run-off and protecting the terrestrial environment from erosion, salinity, and tropical storms and hurricanes.

Central American Atlantic Moist Forests are lush, diverse tropical forests. They serve as a major route for birds migrating between North and South America as well as between lowland and montane forests. In Honduras, this ecoregion comprises the bulk of the northeast coastal lowlands (43,250 km^2).

Central American Pacific Dry Forests are characterized by an extensive (five to eight months) dry season and a semi-deciduous, two-story forest structure. Central American Pacific Dry Forests serve as an inter-continental migratory route for many endemic species of fauna of the region. This ecoregion in Honduras comprises an area of 5,703 km^2.

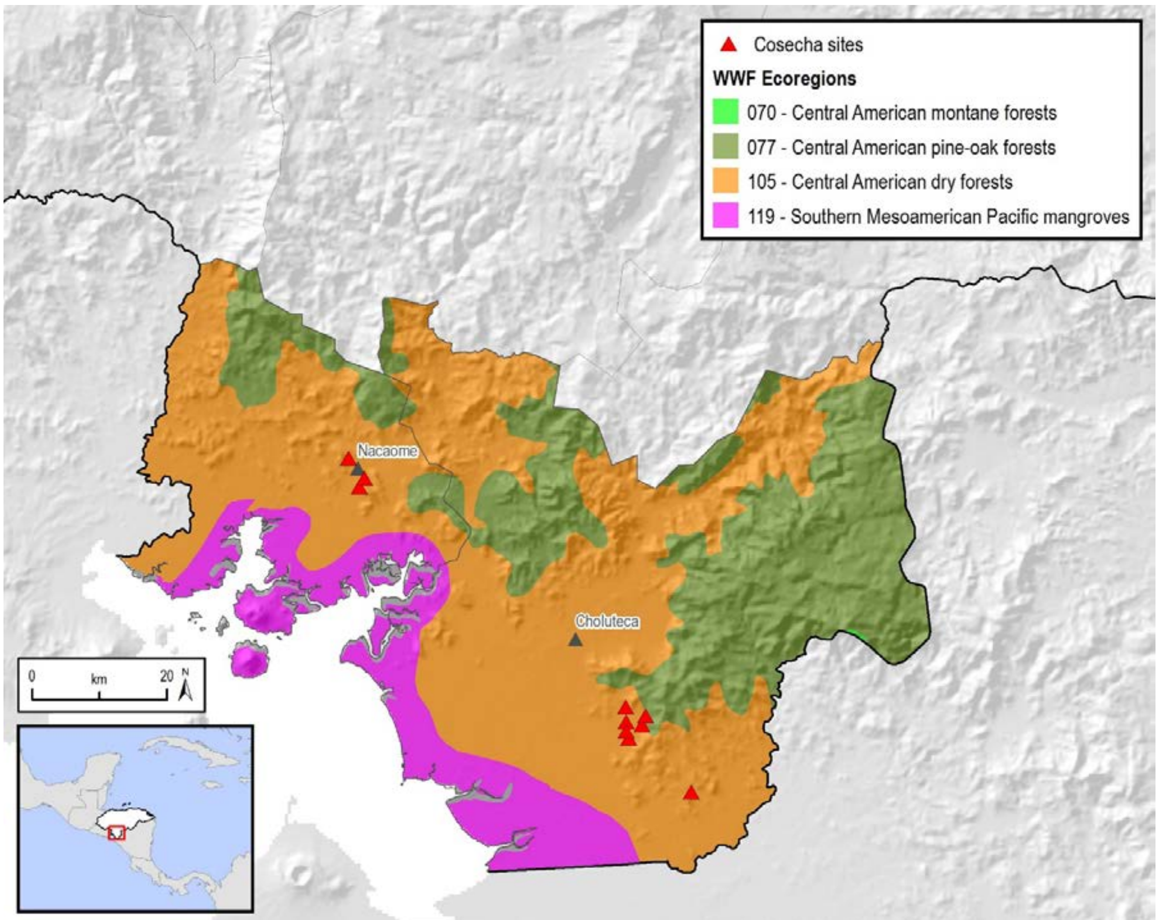
Central American Montane Forests occur in isolated patches on the peaks and slopes of the highest mountains. Their forest profile is comprised of a mosaic of conifers and tropical broadleaf cloud forest vegetation. Central American Montane Forests serve the intercontinental and altitudinal migrations of birds and butterflies migrating into the surrounding Pine-Oak forests. These forests also support North and South American flora and fauna species, of which approximately 70 percent are endemic. In Honduras, these forests exist as isolated habitats and are found in the interior highland area with a total area of 3,085 km^2.

Central American Pine-Oak Forests comprise the largest ecoregion in the country covering 51,161 km^2, and are located between the broad-leafed, evergreen montane forests at higher elevations and the tropical Atlantic moist forests. This is the largest ecoregion in Honduras. These forests serve as the wintering grounds for many migratory bird species and contain endangered populations of various fauna.

Mosquitia (Meskito) Pine Forests are characterized by lowland tropical pine-savanna comprised of a mix of pine stands and open savanna areas. This ecoregion occupies 6,793 km² on the eastern coast of Honduras.

Of these ecoregions, three are found in the Valle and Choluteca departments. The primary ecoregions in Valle and Choluteca are Central American Pine-Oak Forest, Central American dry forest, and Southern Mesoamerican Pacific mangroves (Figure 7).

Figure 7. World Wildlife Fund Ecoregions in Valle and Choluteca

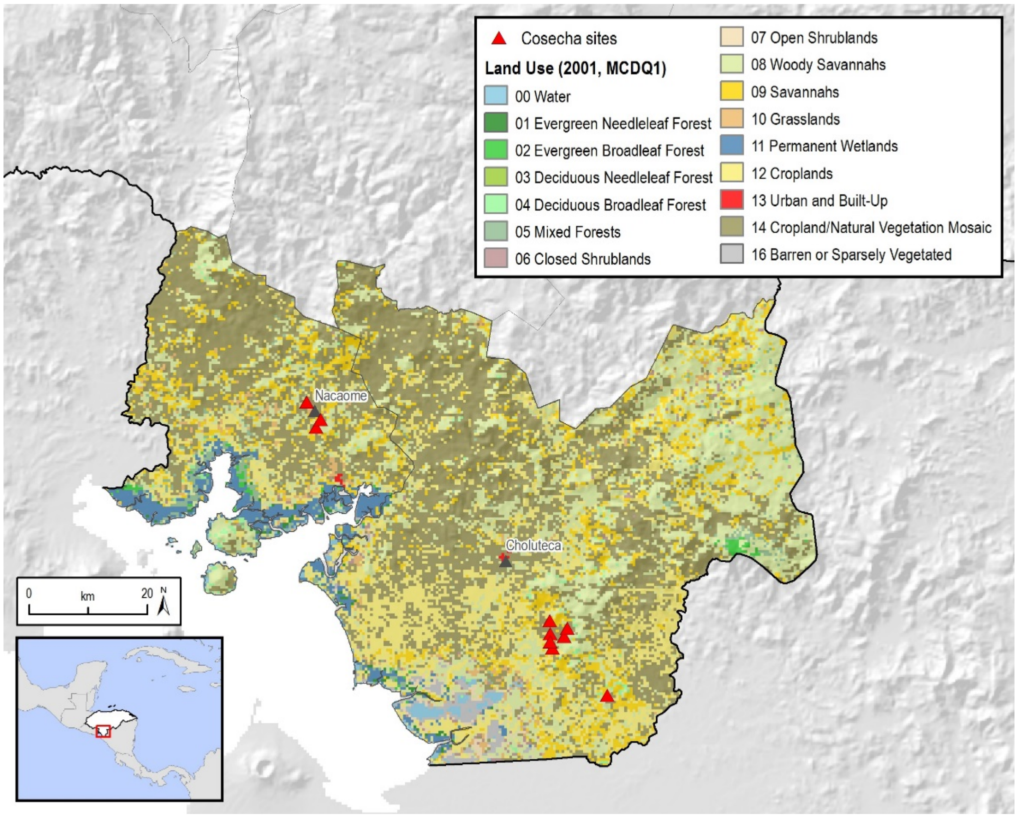


4.3.4 CURRENT STATUS OF FOREST RESOURCES

Using satellite image analysis, Honduras' forest cover can be estimated at 6,600,000 ha (59 percent of the country's surface area), of which ~57 percent is broadleaf forest (3,700,000 ha), ~38 percent coniferous forest (2,500,000 ha), ~2 percent mixed forest (160,000 ha), ~2 percent mangrove forest (121,000 ha), and ~1 percent dry forest (41,000 ha) (INE, 2013).

There is a lack of updated forest inventories for Honduras, so precise knowledge is limited, but forest inventories at regional offices organized by AFE/COHDEFOR (currently Institute of Protected Forest Area and Wildlife Conservation ICF) and the government of Germany have allowed for projects at the national level. The preliminary forestry map of 1995 indicates that forest cover in Honduras is mainly located in the departments of Olancho and Gracias a Dios, with a greater relative density in the department of Gracias a Dios (72 percent) and a greater extension in the department of Olancho. Forest cover has decreased over time due to pressures for use as timber and firewood. The departments of Valle and Choluteca are characterized by croplands and woody savannahs with minimal forest cover, which decreased between 2001 and 2012 (see Figures 8 and 9).

Figure 8. Land Use in Southern Honduras (2001 and 2012)



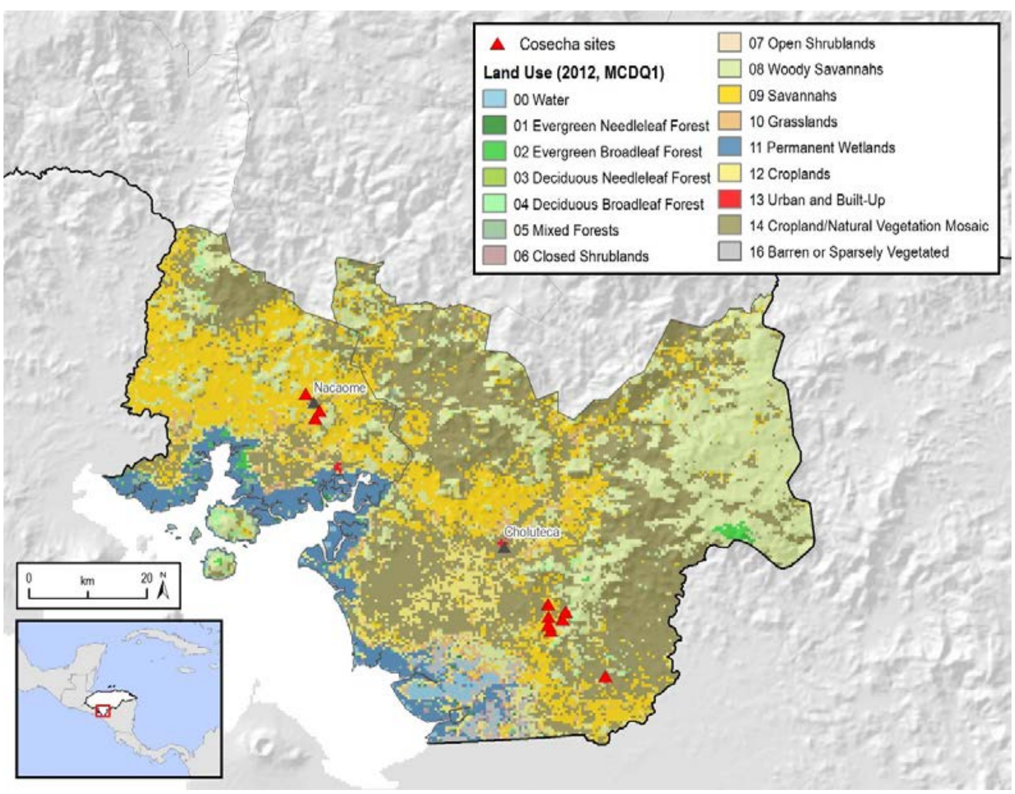
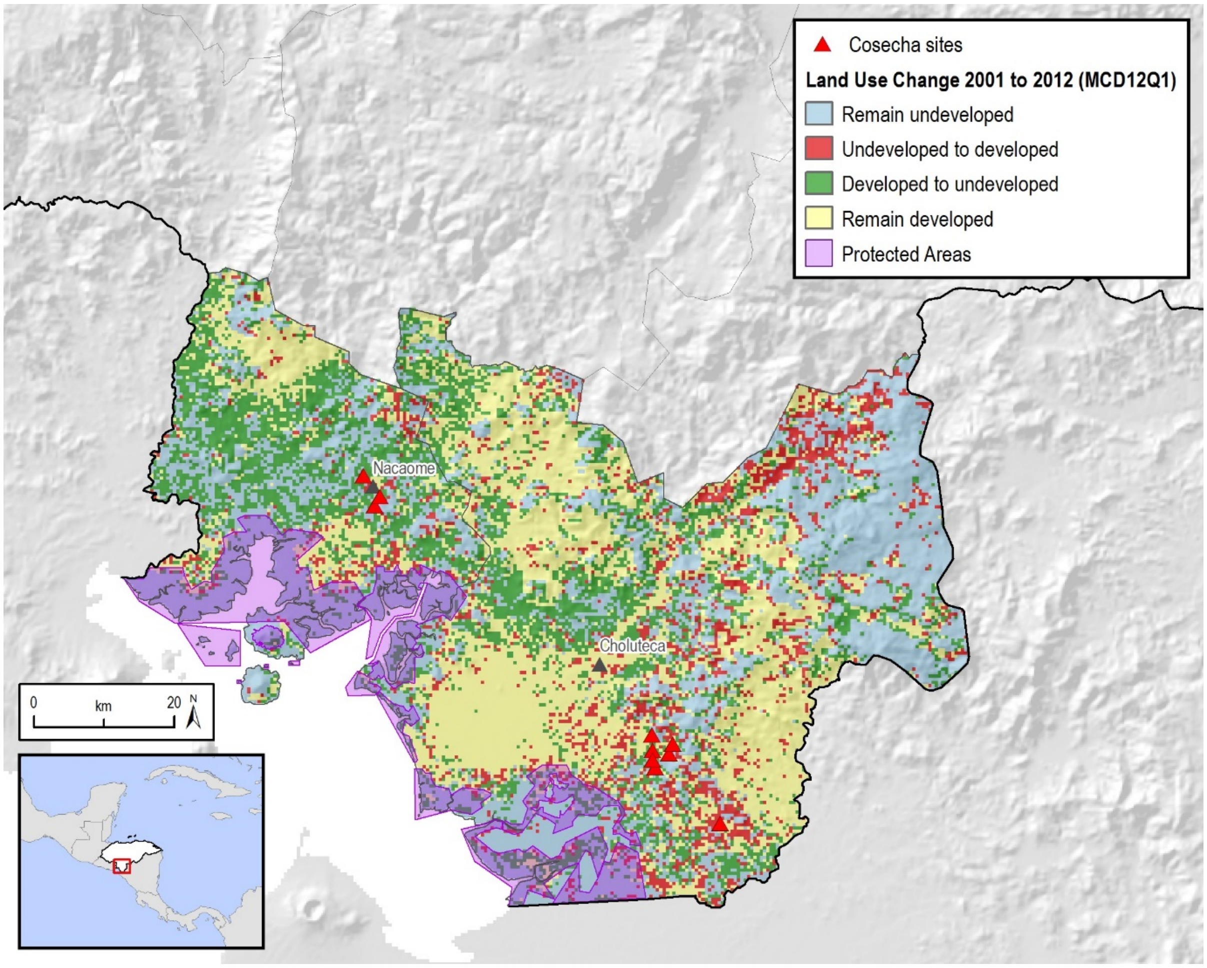


Figure 9. Land Use Change (2001 to 2012)



Between 1990 and 1996, the share of the forestry sector in GDP decreased, with an average contribution to GDP of 3 percent, distributed among forest-related activities and industry. The participation of the wood, paper, and cardboard industries remained stable over the period, although their relative contribution to total industrial GDP was in decline as other industries expanded (e.g., factories in free-trade zones).

The forests provide habitat for approximately 1,100 species of birds, mammals, and reptiles and 5,000 species of plants. Forests also provide high-value ecosystem services, particularly regulation of watershed hydrological cycles dedicated to the production of drinking water, irrigation, industrial, and hydrological uses. Although the contribution of forests to water production is not precisely known, its value as part of the water production system is growing, as evidenced by community (primarily rural) efforts to conserve land with forest cover. In the period between 1988 and 1996, 146 micro water sources and forest sites were declared protected (Honduras Environmental Profile 1997).

4.3.4 SOIL RESOURCES

There are major differences in soil types between mountainous/hilly areas and low-lying deltas. Delta soils are typically derived from fertile alluvial deposits capable of supporting intensive agriculture with appropriate water management. The maintenance of soil fertility in alluvial areas hinges on the maintenance of natural flood regimes. Delta soils tend to be saline in areas affected by saltwater intrusion. This is particularly true where there is an absence of regular freshwater floods. Unlike delta soils, the soils of the interior highland tend to be poor because this region lacks the volcanic ash deposits found in other Central American highland regions.

In the southern, central, and western zones of the country—where slopes are usually above 15 percent, the soil is shallow but fertile, precipitation is low, and the predominant use is clean crops (corn, beans, and millet)—the soil is highly deteriorated. Although there is deep and fertile soil in flat areas, the dry climate limits soil quality and resources. In the Atlantic and eastern zones—with land mainly above a 30 percent slope, deep soil, high levels of precipitation, and low fertility—the soil is susceptible to water erosion when it is not vegetated, or when it is cultivated without soil conservation measures.

In general, soil degradation is occurring rapidly throughout the country, but soil losses are particularly acute in Northern Honduras due to intensive agriculture focused on producing crop commodities, such as coffee and African palm, as well as livestock mismanagement (Blanco-Sepulveda and Nieuwenhuyse, 2011).

4.3.5 WATER RESOURCES AND WATERSHED MANAGEMENT

As a tropical country, Honduras generally has abundant water resources. There are 19 watersheds in Honduras, five on the Pacific slope and 14 on the Atlantic slope (FAO, 2014). The Ulua and Chamelecon Rivers are economically important for their use as waterways for the transport of goods. Numerous other rivers drain northwards from the interior highlands to the Caribbean, and these are critical for ecological maintenance of the broad fertile valleys on the north coast. In 2013, the total storage capacity of the country's reservoirs was 5,805 km^3. The largest reservoir is El Cajon, on the Comayagua river, with a total storage capacity of 5.7 km^3 (FAO, 2014). Lake Yojoa, with a surface area of approximately 90 km^2, is the one large lake in the country (FAO, 2014).

Although Honduras has abundant water resources overall, the geographic distribution of precipitation is very irregular. The basins with higher rainfall are found in areas on the Atlantic side, such as the Cangrejal and Lean River. These receive an average yearly rainfall of 2,700 and 2,500 mm, respectively. The basin with the least precipitation is the Choluteca River in the southwest, with an average yearly rainfall of 1,100 mm. This rainfall is predicted to decrease 30 to 40 percent during El Niño events (SERNA 2014). See Figure 2 for a watershed map of Valle and Choluteca.

During the past decade, Honduras has conducted research on how to increase hydroelectric power to meet energy demand and has made modest advances towards achieving this goal. The country has a total hydropower potential of 1,542 m^3/s, however a small percentage of that potential volume is utilized; currently, 13.5 m^3/sec is used for domestic and industrial use; 75 m^3/s for irrigation; and 242 m^3/s for electricity. As of 2010, the country was exploiting 9 percent of its hydroelectric power potential, an increase from 5 percent in 2005. This is due to the development of several hydroelectric projects during that five-year period (Tabora et al., 2011).

The latest official data on water use in Honduras are from 2009 and indicate that the agricultural sector uses the greatest amount of water, followed by domestic use. Total water demand in 2009 was 2,200 $hm^3/year$, distributed among sectors as follows (Tabora et al., 2011):

- Agriculture: 1,153 hm^3
- Domestic use: 315 hm^3
- Hydroelectric: 300 hm^3
- Industrial: 114.03 hm^3
- Mining: 0.23 hm^3
- Other : 318 hm^3

Most problems associated with the country's water resources can be directly linked to human activities, which have degraded, overexploited, and polluted these sources. In response, Honduras initiated the 2010-2038 Country Vision and the 2010-2022 National Plan, which defined 16 Development Regions according to the main watershed boundaries and existing water resources. Protected Areas in Honduras currently comprise a key component of water resource management strategies.

The 2014 Evaluation of Natural Hydrological Resources indicates that western Honduras generally experiences low surface water and groundwater recharge rates, and a high evapotranspiration potential (SERNA, 2014). Furthermore, studies indicate groundwater is only abundantly available in lowlands in the north of the country, where the water table generally is not significantly reduced, although it can drop a few meters in the dry season. In the central and southern zones, the water table can drop several meters between November and April. The absolute level of water table reduction increases from north to south, significantly decreasing the yield of the wells. In hilly and mountainous regions, scattered springs dry seasonally (Environmental Status Report of Honduras, 2000).

4.3.6 CLIMATE CHANGE

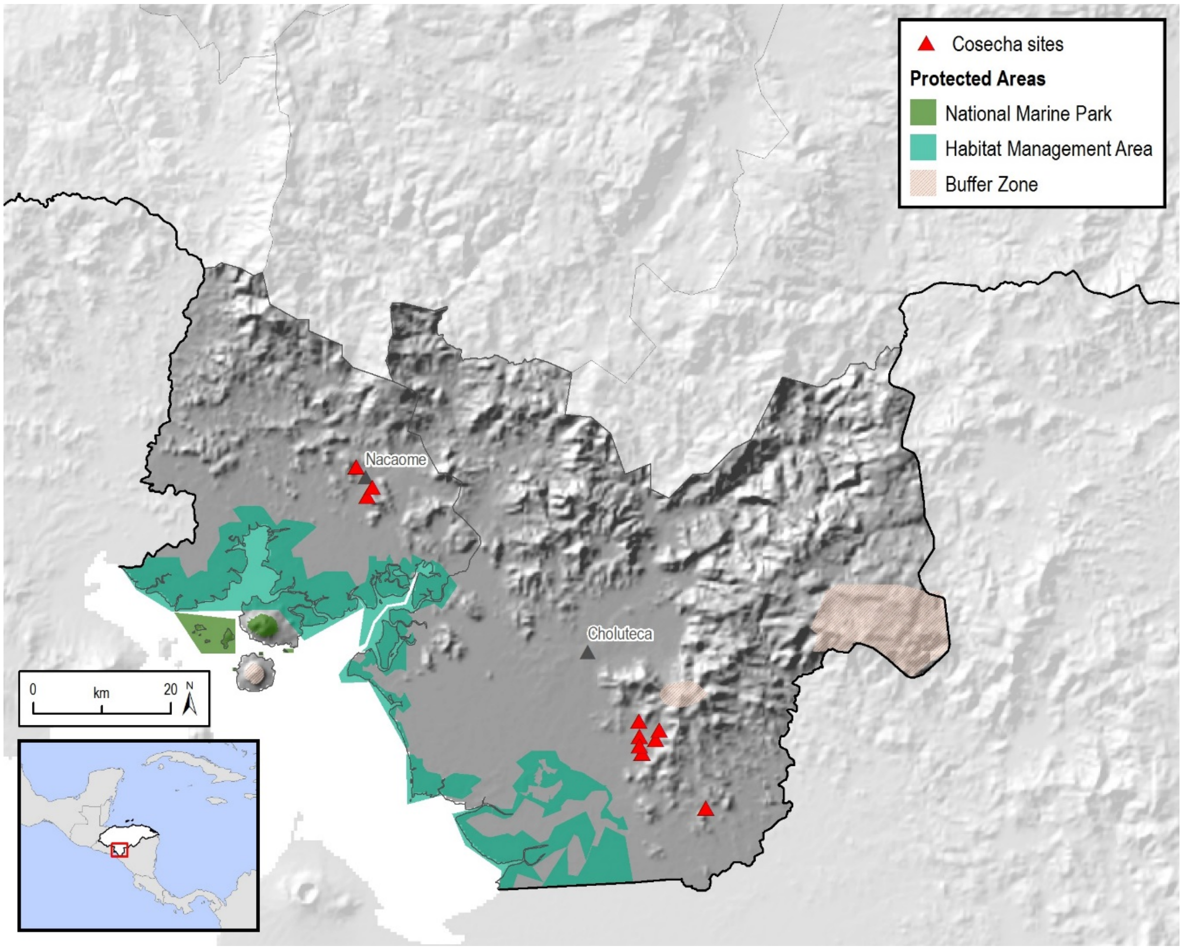
Climate change is affecting agriculture in Honduras. According to the International Hydrological Programme of UNESCO, Honduras is the third most vulnerable country in the world to extreme weather events such as droughts and floods caused by climate change (IHP, 2014). Droughts and floods threaten food security and agricultural yields. Because agriculture contributes to 14 percent of the GDP and 40 percent of the labor force in Honduras, droughts and floods that compromise crop yields for farmers will affect broad swaths of the economy (CIA, 2014).

Honduras has created various agencies to respond to climate change-related events. In 2010, the Climate Change National Office published the National Strategy for Climate Change, offering guidelines and measures to adapt to and mitigate climate change in seven sectors: water resources, forests and biodiversity, marine-coastal ecosystems, human health, risk management and infrastructure, hydroelectric energy, and agriculture (PHI, 2012).

4.4 LOCAL LAND AND NATURAL RESOURCES MANAGEMENT

The primary natural resource management issue in Honduras is a negative feedback loop that includes land stressed by extreme weather events (droughts and flooding), agricultural expansion, deforestation, and high levels of poverty. These factors combine to exert significant pressure on natural resources and ecosystem services. Nonetheless, economic forces and unsustainable patterns of agricultural development are the root causes of erosion and land degradation (SERNA, 2014). The Action Plan against Desertification and Drought (SERNA 2014) classifies current land degradation according to five general themes: soil, water, biosphere, socio-economic, and the dry climate. It further lists causes that contribute to degradation in these areas and the effects of those causes (e.g., poor management of watersheds is listed as a primary cause of degradation of soils, water, and the biosphere). In the project area, the protected areas are concentrated on the coast and, thus, any remnant dry forest or pine-oak forest is vulnerable to degradation (Figure 10).

Figure 10. Protected Areas in Southern Honduras



4.4.1 LAND USE PATTERNS

Although Honduras is well suited for agriculture, only 13 percent of the total surface area of the country is used for agriculture. This percentage is divided into arable land (9 percent) and permanent crops (4 percent). Irrigated land in Honduras covers an area of 875 km^2, while lands used for other purposes represent 87 percent of the country's area (CIA, 2014). Much of the land has been primarily used for pastures or was forested and owned by the government or banana corporations. Since the 1980s, much of the land has been significantly deforested for commercial and subsistence agriculture (Churchill and Dobrowolski, 2002).

See Figure 8 and Figure 9 for visualizations of land use patterns in 2001 and 2012 as well as changes during that period.

4.4.2 POVERTY AND RURAL MARGINALIZATION

Most agricultural lands are farmed by smallholder rural farmers who typically fall under the poverty line. Their crops are used either for personal consumption or for sale in regional or national markets. They face higher production risks because they do not have access to modern agricultural practices and technologies. These factors force rural farmers to expand into new areas as cultivated lands lose productivity with consequent deterioration of soil, forest, and water resources. Reduced soil productive capacity affects a large sector of the population, especially subsistence farmers. The negative effects include crop failure, cyclic food shortages, and malnutrition of the population, mainly in rural areas.

4.4.3 LACK OF STRATEGIC PLANNING PRACTICES FOR LAND USE

The high basins of major rivers in the country are significantly deforested as a result of concentrated agricultural activities and generally inappropriate land use. The high rate of deforestation contributes to the systematic alteration of the hydrological regime, resulting in floods, droughts, and high levels of erosion; the consequent siltation of rivers, lakes, and other wetlands; and reduction or deepening of aquifers.

Furthermore, the primary cultivated areas are located on land with slopes greater than 30 percent where few soil conservation practices are implemented. The combination of deforestation, steep slopes, and poor soil conservation creates high potential for erosion, causing loss of topsoil and negative impacts on water quality.

The continued use of traditional farming methods, combined with the fragmentation of land, causes an accelerated deterioration of soil, forests, and watersheds. Additionally, the low coverage and poor maintenance for irrigation systems suggest that water and land resources are currently not being used efficiently. Accordingly, expansion of micro-drip irrigation could increase productivity on cultivated lands, while potentially minimizing pressures on forests.

Public and private assistance services directed to small and medium sized farmers have not resulted in improvement in cost or sustainability of production systems. Additionally, limited access to credit restricts small farmers from applying technological, environmental, and economic practices.

5.0 ENVIRONMENTAL CONSEQUENCES

As required by 22 CFR 216.6, this section provides the analytic basis for Section 3 ("Alternatives, Including the Proposed Action"); describes the environmental and social impacts of the alternatives (the potentially significant issues); and describes any adverse impacts that cannot be avoided. It includes a discussion of direct and indirect effects and their significance; short and long-term effects and their significance; and cumulative impacts, irreversible and irretrievable impacts, and unintended consequences.

The Scoping Team identified the following potentially significant issues to be evaluated in the EA:

1. Maintenance of environmental water flow in the stream channels below the reservoirs;
2. Factors related to construction and design of the reservoirs for long-term sustainability, including: assessment of soil type; patterns of precipitation, including long-term patterns influenced by climate change; water volume; slope; evapotranspiration potential, specifically the surface-area-to-volume ratio; and the condition of the watershed;
3. Plans for management of cattle and/or other livestock near the reservoir sites, including exclusion of livestock and provision of other water sources for the livestock;
4. Technical assistance for the following:
    a. Planning and implementation of reforestation in the reservoir watersheds (including cultivating saplings, species selection, planting, maintenance, etc.)
    b. Managing tilapia in the reservoirs where project implementers introduce tilapia to control mosquitos;
5. Community outreach and training to reduce and mitigate unintended and unsustainable impacts on wildlife, including unsustainable levels of hunting because wildlife might be attracted to the reservoirs as a water source;
6. Micro-watershed management for long-term sustainability of the water source and reservoir; and
7. Community management of the reservoirs, especially adding new beneficiaries to the producer groups.

5.1 ALTERNATIVES ELIMINATED FROM ANALYSIS (AND RATIONALE FOR ELIMINATION)

The EA Team did not eliminate any of the preliminary alternatives proposed in the Scoping Statement from evaluation in the EA. However, it is important to note that the proposed action alternative and Alternative 4 (rainwater harvesting with sprinklers) present similar potential environmental impacts and benefits. As discussed in Section 3.4, the proposed action uses a more water-efficient technology to irrigate crops.

5.2 COMPARISON OF ENVIRONMENTAL IMPACTS OF ALTERNATIVES

This section discusses the comparison rankings shown in Table 14. The matrix and discussion provided in Table 14 is for comparative purposes only. Section 5, Environmental Consequences, provides the analytic basis for the comparisons based on specific ecological, social, and economic characteristics as described in the Affected Environment (Section 4).

Table 14 lists the potentially significant issues identified in the Scoping Statement and compares relative impact of the alternatives to the No Action alternative. A narrative of the rankings is included below the table. The rankings provide the basis of the environmental consequences analyses in Section 5.3.

Table 14 Comparison of Alternatives

NO.	POTENTIAL SIGNIFICANT ISSUES	ALT 1: NO ACTION	ALT 2: PROPOSED ACTION	ALT 3: GROUND WATER WELLS FOR IRRIGATION	ALT 4: RAINWATER HARVESTING + SPRINKLERS
1	Loss of environmental flows in streams below the reservoir	0	(-)	(-)	(-)
2	Reforestation planning and implementation (including cultivating saplings, species selection, planting, maintenance, etc.), including micro-watershed management	(-)	+	(-)	+
3	Risk of dam failure, high evapotranspiration, and erosion	0	(-)	0	(-)
4	Risk of increasing mosquito-borne diseases; Introduction of tilapia to the reservoirs to manage mosquitos	0	(-)	0	(-)
5	Impact of cattle and/or other livestock on the reservoirs	0	(-)	0	(-)
6	Unintended impacts on wildlife, especially unsustainable hunting of wildlife – oasis effect of wildlife	0	(-)	0	(-)
7	Impacts on threatened and endangered species	0	(-)	0	(-)
8	Conflict between beneficiaries and non-beneficiaries	0	(-)	(-)	(-)
9	Diversion and withdrawal of water during operation of irrigation schemes could impact other water users	0	(-)	(-)	(-)

Ranking scale: a (-) is adverse effect; 0 is neutral or no change; (+) is a positive effect/benefit.

5.3 ENVIRONMENTAL CONSEQUENCES BY ALTERNATIVE

5.3.1 ENVIRONMENTAL FLOWS

Environmental flows are defined as the water flow regimes needed to maintain important aquatic ecosystem services (Hirji and Davis, 2009). Specifically, they are defined as the "quality, quantity, and timing of water flows required to maintain the components, functions, processes, and resilience of aquatic ecosystems which provide goods and services to people" (Nature Conservancy 2006). Environmental flows vary seasonally both throughout a year as well as year-to-year: this is called the flow regime. In Southern Honduras, the seasonal pattern is a dry season (November-April); a wet season (May-June); the canícula, which is characterized by decreased rains in July and August; followed by a second wet season from August-October. Alternatives 2 and 4 propose storing stream flows during the wet season for use in the extended dry season. The potential impacts of water storage on environmental flows are affected by the characteristics and conditions of the watershed. Geomorphology, geology, climate, and land cover all affect the quantity, quality and timing of water flow in the watershed. The watersheds in Southern Honduras are steep, with an average slope of 17 percent, and a land cover ratio of less than 50 percent; most of the lands in these watersheds have been cleared of natural vegetation and converted to croplands or pastures (TetraTech ARD 2013). Thus, during the rainy season, these factors translate dry stream beds into a system of rapid surface and subsurface flows, high erosion potential, and low infiltration rates. While Alternatives 2 and 4 will alter the velocity of water moving downstream, the reservoirs may provide positive benefits by decreasing erosion potential and soil loss along the watercourse and allowing for infiltration of water in the immediate area of the reservoir. The reservoirs are designed to allow for overflow such that water will spill over into the natural streambed once the reservoirs are full. If the reservoirs do not fill completely to allow overflow, then surface water will not reach downstream riparian areas, which could have significant negative impacts on aquatic organisms, riparian vegetation, and downstream users.

Although surface water flow will not be obstructed by dams in the No Action alternative, the existing stream dynamics will continue, which could further incise streambeds and exacerbate erosion under the current land use scenario. Of course, this assumes that the current land use scenario persists, resulting in further land conversion, and exacerbating the existing soil erosion and low infiltration rates. Alternative 3 proposes extracting groundwater for irrigation by drilling wells. Pumping groundwater can also reduce environmental flows by lowering the water table and altering the direction of groundwater flow (USGS 2015). In this scenario, pumping extracts groundwater that normally would contribute to the base stream flow. Pumping may also draw stream water into the groundwater system, reducing the volume of water in the stream.

Alternatives 2 and 4 include a reforestation program for the micro-watersheds above the proposed reservoirs. This program provides a significant benefit by protecting vegetation and managing surface runoff and soil infiltration, maintaining watershed hydrology (TetraTech ARD 2013). In forested watersheds, most stream flow comes from infiltrated groundwater, while only a small portion of total stream flow comes from surface runoff (4-8 percent) (TetraTech ARD 2013). Thus, increasing forest cover in the watersheds above the micro-reservoirs will support improved groundwater infiltration, reduce erosion, and improve wildlife habitat. Alternatives 1 and 3 do not include any reforestation components and, thus, do not generate similar potential benefits.

Direct Impacts: Construction of earthen dams will reduce peak flows of streams during the rainy season and may reduce flooding in the watersheds (Government of Canada 2013). Flow rates for the targeted ephemeral streams are unknown, so the anticipated change in volume of peak flows cannot be quantified. However, a study in Sonoma County, California, an area also characterized by a prolonged dry season and an intense rainy season (October-April), indicates that small-scale reservoir impacts typically occur at the onset of the water year (when reservoirs are assumed to be empty). As the reservoirs fill over time and water is released into the system via spillover, impairment is lowered as water is released through the drainage network (Deitch et al 2013). It is important to note, though, that watershed processes vary over space and time and the hydrologic and ecological impact will differ depending on size, hydrologic regime, and location in the drainage network (MJ Deitch et al 2013). In addition, earthen dams do seep water downstream (FAO 2010), which may partially mitigate the loss of peak flows in the drainages.

The direct impact of Alternative 3 is that the groundwater wells would lower the water table, likely decreasing flow to streambeds and in-stream flows. Similar to impacts posed by Alternatives 2 and 4, the number and density of wells would determine the overall effect on the water table and aquifer.

Indirect Impacts: Impairment of environmental flows downstream in Alternatives 2 and 4 may negatively impact riparian plant and animal communities, reduce habitat connectivity, and alter higher trophic levels throughout the drainage. Additionally, reduction of peak flows may reduce sediment load in streams and alter streambed characteristics. Finally, the change in flow could impact the quality of riparian vegetation downstream if sufficient groundwater or surface water is not available.

An indirect impact of Alternative 3 is that the water table may be lowered and subsequently reduce the groundwater flow and base flow in the stream beds. Furthermore, groundwater pumping can pull water away from stream beds, thus impacting environmental flow via a different mechanism (USGS 2015). If wells are not properly covered, contaminants could be introduced to the system and migrate through the aquifer.

Cumulative Impacts: Quantifying the complex impacts of small reservoirs in a catchment area is challenging and may have variable impacts both temporally and spatially. The impact of small reservoirs will attenuate over time as rain falls and reservoirs fill and discharge more water downstream (assuming that normal rainfall occurs and that the reservoirs fill to the point where excess water can spill over). Abstracting water upstream may impact the availability of surface and groundwater downstream, especially for the large-scale agriculture on the plains near the Gulf of Fonseca, where sugar cane and melons are cultivated; these crops use both flood irrigation (sugar cane) and groundwater for irrigation. Potential conflicts among users may arise if the use of reservoirs expands to scale and appropriate system-wide hydrologic studies are not undertaken. Future cumulative impact analysis of additional reservoirs will need to integrate the spatial aspect and relationship of all users in a drainage system as downstream impacts are influenced by tributary confluences, the size and locations of other reservoirs on those tributaries, and the water rights within the system. This requires a system-wide hydrological analysis to support integrated watershed management.

5.3.2 RESERVOIR CONSTRUCTION AND DESIGN

Alternatives 2 and 4 require construction of reservoirs, including earthen dams to retain the water, while Alternative 3 requires drilling wells. Alternative 1 does not require any construction activities. The reservoirs proposed in Alternatives 2 and 4 would be highly beneficial to smallholder farmers to provide a sustainable source of water during the dry season and allow cultivation of higher-value crops during other seasons. Alternative 3 could potentially provide similar benefits, although groundwater resources in the region are unknown and potentially unreliable, and the cost of drilling wells is relatively high. During the scoping phase, some of the communities expressed concerns about the potential for failure of the retention wall during extreme weather events. This is an important concern. However, the construction designs for each dam have considered high flow scenarios in determining the height and length of each dam as well as the types of construction materials to maximize the longevity of each dam. Alternative 3 requires perforation of wells, which would require extensive hydrogeological surveys to determine locations. In addition to the cost of hydrogeological studies, drilling multiple wells for irrigation is cost-prohibitive. Although there is a possibility of the reservoirs' retention walls failing, the existing stream channels are flashy and able to hold high volumes of water. Furthermore, this concern has been addressed in the reservoir designs by reinforcing the "toe wall"—the downstream side of the dam—in construction (see Annex D, Rainwater Harvest Designs).

Direct impact: Failure of the earthen dam would release a high volume of water downstream. This type of flow regime is similar to the baseline condition; as such, it would not likely cause major environmental impacts, with one exception: If the dam failure occurred after sediment built up behind the earthen dam, dam failure could cause a large slug of sediment to move through the drainage system and impact water quality of tributaries. In addition, the pulse of a high volume of water and sediment could negatively impact communities or infrastructure downstream, especially if communities become accustomed to the flow control that the reservoirs provide. Integrating an earthen spillway can mitigate the possibility of dam failure and allow water to reach downstream (FAO 2010).

Indirect impact: Dam failure could temporarily mimic the natural flow regime for the drainage system and temporarily restore or augment baseline stream conditions. The indirect impact of dam failure would be that water would be unavailable for irrigation, and the goals of intensifying crop production would not be met. Additionally, dam failure could negatively impact wildlife by removing a water source.

Cumulative impact: Dam failure could be caused by site-specific factors, including construction materials, water volume, failed exclusion of livestock and large animals, among other factors. However, failure of even a single dam might diminish the probability of applying this alternative for irrigation on a broader scale.

Alternatives 1 and 3 do not require construction of a reservoir and are not associated with impacts related to dam failure.

5.3.3 MANAGEMENT OF MOSQUITOES AND VECTOR-BORNE DISEASE

Alternatives 1 and 3 will not use tilapia to manage mosquitos because they do not require construction of reservoirs. Mosquito-borne diseases such as malaria, dengue, and chikungunya are public health concerns associated with Alternatives 2 and 4. Several reservoir sites are located at least 1 km away from villages and are less likely to cause the spread of disease. To mitigate the potential impacts in sites situated closer to inhabited areas, some of the project proponents have suggested introducing tilapia to the reservoirs as a biological control to manage mosquitos. The use of tilapia at selected reservoir sites could provide additional benefits, including increased awareness of disease prevention (malaria and dengue), an additional source of protein for the community, and a potential additional source of income for the community. However, a major concern with introducing tilapia is that the communities are not sufficiently trained in management of the fish. The project will need to mitigate this concern via training and capacity building in the communities where tilapia farming is planned.

Direct Impacts: Alternatives 2 and 4 involve construction of reservoirs that create a potential breeding ground for mosquitoes, which are vectors of disease of concern in the region, including malaria, dengue, and chikungunya. Chikungunya virus is transmitted to people through daytime female mosquito bites and is most often spread to people by *Aedes aegypti* and *Aedes albopictus* mosquitoes (CDC 2015). These mosquitoes hatch on the surface of ponds (specifically, the *Aedes aegypti* species); they also transmit the dengue virus. Mosquitoes become infected when they feed on a person already infected with the virus. Infected mosquitoes can then spread the virus to other people through bites. Dengue epidemics occur in Honduras, including the southern region, on a 3-5 year cycle, while chikungunya virus has been identified in over 60 countries in Asia, Africa, Europe and the Americas. Malaria presents a moderate risk in Southern Honduras and is present throughout the country (Jovel et al. 2011). It is spread by *P. vivax* (93%) and *P. falciparum* (7%). A significant risk factor for chikungunya, dengue, and malaria is the proximity of mosquito breeding sites to human habitation, however 9 of 10 sites are located at least 1km away from homes, which should minimize the risk of disease transmission.

The **indirect impact** of inappropriate siting of reservoirs and/or lack of pro-active approaches for mosquito management could cause a significant public health issue by spread of chikungunya, dengue, and to a lesser extent malaria in Southern Honduras.

Cumulative impacts: The cumulative impact associated with Alternatives 2 and 4 could create persistent issues with mosquito-borne diseases, especially if the reservoirs become more prevalent as an irrigation strategy and if they are constructed close to villages. This would require consideration of location in site selection and design. Although mosquito-borne disease is a persistent risk in Southern Honduras, Alternatives 1 and 3 do not present the same impacts because they do not include construction of reservoirs.

5.3.4 WILDLIFE AND LIVESTOCK MANAGEMENT

Alternatives 2 and 4 will create a body of water that could attract both livestock and wildlife as a drinking water source. This is not the case for Alternatives 1 and 3. During the scoping visit, the communities reported observing wildlife drinking at two sites that were previously excavated, and the scoping team observed pigs wallowing in one of those sites. Under Alternatives 2 and 4, there is a risk that livestock will trample and damage the retention wall of the reservoirs, rendering them ineffective. Livestock might also contaminate the water with urine and feces, which could have health impacts on people, especially because livestock are common carriers of fecal bacteria that can make people sick. In addition, the reservoirs might attract wildlife, which could be hunted by community members and negatively impact threatened or endangered species. However, livestock and large wildlife can be excluded from the reservoirs using fences. Alternatives 2 and 4 also include reforestation and capacity building to improve habitat and increase awareness regarding sustainable hunting. If Alternative 3 were broadly implemented, the impacts of pumping could negatively impact groundwater-dependent species and ecosystems; these are likely undocumented in Southern Honduras. Impacts from Alternatives 2 and 4 would need to be mitigated with measures to exclude livestock from the reservoirs and improve wildlife management in the project area.

All of the alternatives present potential impacts on threatened and endangered species. Alternatives 2 and 4 could impact environmental flows, and the reservoirs might attract wildlife to the sites; Alternatives 1 and 3 largely maintain the status quo and do not include mitigation measures that integrate reforestation and natural resource management capacity building into implementation.

Direct, indirect and cumulative impacts: As described in the Affected Environment section (Section 4.0 above), livestock and wildlife use the watersheds and lands where the proposed action would occur. Livestock graze on the hillsides and fields surrounding the proposed project sites, and wildlife are hunted in the hills in the watersheds. The direct impacts of Alternatives 2 and 4 include negative impacts to wildlife because wildlife might be attracted to the reservoirs as a source of drinking water; consequently, resident farmers might hunt the wildlife at unsustainable levels. Wildlife habitat in Honduras is already under pressure from deforestation and agricultural expansion; further pressure from exploitation could increase threats to sensitive species. However, an **indirect impact** of Alternatives 2 and 4 may result in improved natural resource management, including wildlife, as capacity is built within the communities to understand the importance of biodiversity and wildlife for sustainable water supply and healthy ecosystems via mitigation measures outlined and implemented per the EMMP. Alternatives 2 and 4 could actually generate some positive **cumulative impacts** with proper mitigating conditions designed and implemented. In addition, as production intensifies on the targeted agricultural lands, food security will improve, and this may decrease hunting pressures on wildlife in the area. Reforestation of the watersheds immediately above the proposed reservoir sites is another component of the project that could ultimately have net positive impacts on wildlife habitat, water quality, and water infiltration rates, among others.

Livestock also may directly impact the reservoirs by using them as a water source; the integrity of the reservoirs would be negatively impacted by livestock use, both through structural damage as well as potentially contaminating the water.

5.4.4 EQUITABLE WATER USE AND DISTRIBUTION OF BENEFITS

Equitable water use and benefits within the communities should also be considered when evaluating alternatives. Potential impacts include conflicts between beneficiaries and non-beneficiaries as well as downstream users. These potential conflicts especially pertain to Alternatives 2 and 4, but Alternatives 2 and 4 also propose community-based projects that can benefit a broad group of people and potentially could improve infiltration of water, improving quality and availability of water resources (**indirect impacts**). In contrast, Alternative 3 (groundwater wells) generally benefits a single owner, lowers the groundwater table, and can deplete surface water resources. In this scenario, risk of conflict is reduced, but not eliminated. Drilling numerous wells in the region could cause groundwater overdraft and conflict among users of both surface water and groundwater. Effects of groundwater overdraft include aquifer depletion, increased groundwater pumping costs, localized land subsidence, and the costs of replacing or deepening a well (Stanford University 2014).

The majority of small-scale agriculture in Southern Honduras relies upon rainfall in order to cultivate crops twice a year. In drought and El Niño years, farmers are either unable to cultivate crops or may only be able to cultivate crops once a year. Alternatives 2 and 4 focus on development of community-based irrigation projects whereby beneficiaries form an association to operate and manage the reservoir, and this should result in improved social cohesion and distributed benefits (**direct impacts** of Alternatives 2 and 4). A case study in China indicated that when input costs are manageable for the communities and government, the higher profits from production recover investments quickly (Zhu and Li, 2003). The project used a decentralized approach based on village technicians assisting farmers to build their own systems. The project emphasized preparation, organization, and management during implementation. Feasibility research was conducted for several years before the project was expanded into new areas. Technical guidance and training courses were provided at different levels, which contributed to the project's long-term success. The No-Action alternative (Alternative 1) would not develop a system for water distribution or provide an incentive for development of producer associations for information and cost-sharing. Alternative 3 would benefit fewer users, decreasing the broader impact of increased agricultural productivity on food security and climate change resilience.

5.5 CLIMATE CHANGE CONSIDERATIONS

The potential for a significant and abrupt shift to a drier climate in Southern Honduras increases the urgency to undertake programs to improve resiliency, such as reforestation of watersheds, soil conservation, and improved water management. Climate model predictions suggest that Southern Honduras may be a "hotspot" of climate change stress by 2050, and key crops would experience greater climate stress in a warmer, drier climate, possibly requiring farmers to switch crops or pushing farmers into lands at higher and cooler elevations. Under the predicted scenario, ecology and hydrological sensitivity increases and may cause a significant ecological shift in the region. The shift would potentially degrade hydrological resources in the region caused by a decrease the zone of wetter upland forest "leading to a decreased ability of the affected watersheds to retain water, retard runoff, and recharge the upland filtration zone." Furthermore, El Niño strongly influences temperature and rainfall in Southern Honduras, which could further exacerbate the predicted climate change impacts. Thus, actions to increase resiliency combined with measures to improve watershed health are essential components to improve climate change resiliency.

The outcomes of the proposed action (Alternative 2) and all of the alternatives are highly dependent on regular and predictable rainfall—whether it's to fill reservoirs, recharge groundwater, or support rain-fed agriculture. The period from 1999-2013 was wetter than normal in Southern Honduras (TetraTech ARD 2013), but during the past two years the region has experienced significant drought, possibly associated with El Niño conditions. Southern Honduras' vulnerability to climate change is examined in-depth in the *Vulnerability and Resilience to Climate Change in Southern Honduras* report (TetraTech ARD, 2013). The report indicates that climate change impacts in Southern Honduras are expected to raise temperatures by 2ºC with a 10-20% decrease in precipitation by 2050, increasing the importance of capturing irregular rainfall for irrigation, but also potentially limiting the long-term utility of the small-scale reservoirs if precipitation is insufficient to fill them.

5.6 IRREVERSIBLE/ IRRETRIEVABLE COMMITMENTS OF RESOURCES

Irreversible and irretrievable commitments of resources are defined as impacts or losses to resources that cannot be recovered or reversed. Examples of an irreversible commitment of resources would be permanent conversion of wetlands or loss of cultural resources, wildlife, agricultural, and socioeconomic conditions. Irreversible commitments are permanent and include the loss of future options. Irretrievable commitments of resources are usually applied to the loss of production, harvest, or use of natural resources. For example, some timber production from an area is lost irretrievably when used as a winter recreation site; the production loss is irretrievable, but the action is not irreversible. If the land use changes, timber production could resume.

The proposed project (Alternative 2) would require an irretrievable commitment of natural resources from direct consumption of fuel and construction materials for the construction of the reservoirs and use of the irrigation equipment. The following are irretrievable impacts associate with the proposed project:

- Water quantity and quality – water will be stored in small-scale reservoirs for use in irrigation. Excess water is expected to spill over the earthen dam into the existing stream channel.
- Soil and vegetation: Soil and vegetation inundated by the small-scale reservoir would be irretrievable losses but could be recovered if the small scale reservoir were no longer utilized.
- Agricultural: Irretrievable impacts would occur on the agricultural lands at the reservoir site; however, these losses might be offset by increased production elsewhere. Loss of livestock grazing areas are irretrievable impacts.
- Wildlife (terrestrial and aquatic): Removal or disturbance of habitat during project construction and implementation could create irreversible and irretrievable impacts. Aquatic and riparian habitat could be irreversibly affected in the stream channels below the earthen dam sites.
- Land use: Use of land for the reservoirs and associated infrastructure would be an irreversible impact.
- Cultural resources: Removal or disturbance of previously unidentified cultural resources would result in irretrievable and irreversible loss of cultural information.

6.0 ENVIRONMENTAL MITIGATION AND MONITORING PLAN

This section presents a proposed environmental mitigation and monitoring plan intended to avoid, minimize, or mitigate the potential adverse impacts of the proposed action. The project should also follow the best practices outlined in the Sector Environmental Guidelines for Agriculture and Construction available at www.usaidgems.org/sectorguidelines/. The Sector Environmental Guidelines provide both visual field guides and best management practices for agriculture and irrigation projects.

Table 15 Environmental Mitigation and Monitoring Plan (EMMP)

NO.	CONCERN	ISSUE	MITIGATION MEASURE	INDICATOR & FREQUENCY	RESPONSIBLE PARTY
1	Maintenance of environmental water flows in the stream channels below the reservoirs	The reservoirs will subsume sections of ephemeral stream channels and will abstract flow downstream until the reservoirs fill sufficiently to allow overflow. Since stream volumes are unknown and the potentially impacted species are also unknown, restricting water flows could negatively impact downstream riparian vegetation, species, and communities.	The reservoir design should allow for sufficient downstream water flows—via earthen spillways, controlled releases, or other mechanisms—sufficient to permit existing downstream flora and fauna to thrive.	Presence or absence of a functioning mechanism to allow downstream flow Condition of riparian vegetation within 500 m downstream of each dam (width of riparian corridors; observations of changes in baseline conditions of riparian vegetation, including digital photos of riparian vegetation taken from the same fixed locations along a 500 m transect downstream of each dam) <u>Frequency</u>: One time prior to commencement of construction and four times/year (quarterly) after construction is complete	Global Communities/Agrolibano
2	Risk of dam failure, high evapotranspiration, and erosion	Soil type, location, slope, and condition of the micro-watersheds are all important design factors for the success of the reservoir program Dam failure could negatively impact downstream users as well as reduce the potential for success of the project	For each reservoir site, develop and complete a checklist of the criteria used to select each site, including the location in the micro-watershed, dominant soil type, slope, and general condition (forested or deforested) of the watershed Provide technical assistance to ensure that the earthen dam meets engineering specifications ensuring stability and that newly excavated slopes of the reservoir	Completed checklist for each site including: soil analysis, slope, watershed condition <u>Frequency:</u> Prior to commencement of construction Verify that construction is consistent with design drawings; note and report deviations from designs. Visual inspection of earthen dams <u>Frequency:</u> Immediately following construction and twice annually thereafter (once during rainy season, once during the dry season)	Global Communities/Agrolibano/CIAT

NO.	CONCERN	ISSUE	MITIGATION MEASURE	INDICATOR & FREQUENCY	RESPONSIBLE PARTY
			can be stabilized with a fast-growing native grass, such as the native star grass and/or a legume to enrich the soil Plant fast-growing native grasses and / or legumes on disturbed soils to stabilize and prevent run-off; tend plantings to ensure that they survive and grow	Take digital photos to document that reservoir slopes and earthen dams are stabilized with vegetation Frequency: four times/year (quarterly) after re-vegetation is complete	
3	Reforestation planning and implementation (including cultivating saplings, species selection, planting, maintenance, etc.), including micro-watershed management	Producers generally do not know which species should be used for reforestation based on the objectives of forest plan. In this case, the main objective is reforestation for conservation. Although some communities are interested in planting eucalyptus as a rapid growth species, eucalyptus is an exotic invasive species in Honduras with high water requirements; thus, it should not be used. The lack of knowledge about the selection of species, plantation management, maintenance, etc., will be a problem for conservation of reservoirs unless appropriate technical assistance is provided.	Provide technical assistance and training for all phases of reforestation planning and implementation, including: 1. Objectives and methods for reforestation 2. Species selection 3. Cultivation and planting of, and caring for, native trees 4. Monitoring tree survival	1. Number of beneficiaries trained on reforestation techniques, including where to plant trees, which species are appropriate, planting patterns, maintenance of plants, etc. 2. Number of agreements/commitments formalized with the community for the restoration of forests 3. Identification and cultivation of a selected list of suitable native species 4. Number of producers trained in cultivation of saplings 5. Number of stems planted and number that survive 6. Number of stems planted to replace saplings that do not survive Frequency: Trainings and agreements should be reported every six months (twice annually) Indicators related to reforestation, including tree survivorship, should be inspected and recorded every six months (twice annually)	Global Communities/Agrolibano/CIAT

NO.	CONCERN	ISSUE	MITIGATION MEASURE	INDICATOR & FREQUENCY	RESPONSIBLE PARTY
4	Management of tilapia for mosquito control	One possible impact on reservoirs is an increase in the number of mosquitos that cause certain diseases such as malaria, dengue, and chikungunya. These diseases are listed as recurrent in the project area of intervention, especially during the winter. Although the reservoirs are typically located away from the beneficiary populations, there are still significant public health risks, especially for those responsible for maintaining reservoirs with pipe connections for drip irrigation. Although producers noted that they intend to control mosquitoes by introducing tilapia and perhaps other types of fish in the reservoirs, producers were not aware of specific management techniques or requirements to do this. Tilapia have the potential to outcompete native species in aquatic environments, thus impacting aquatic biodiversity.	Provide trainings and technical assistance for sustainable, effective management of mosquito-borne diseases (for example, altering the level of the reservoirs, flushing stagnant waterways). Train community members that intend to introduce tilapia into reservoirs on techniques for how to do this properly, including using only a single sex fish to avoid reproduction, and techniques to avoid release of fish downstream	1. Report to USAI/GDL BEO the specific techniques taught to manage tilapia at each reservoir where tilapia will be introduced Frequency: Before trainings commence 2. Survey for mosquitos in the immediate vicinity of each reservoir and record results Frequency: Twice during each rainy season 3. Number of beneficiaries trained in mosquito management and tilapia management Frequency: Record every six months (twice annually) 4. Number and locations of reservoirs stocked with tilapia Frequency: Record every six months (twice annually)	Global Communities/Agrolibano/CIAT

NO.	CONCERN	ISSUE	MITIGATION MEASURE	INDICATOR & FREQUENCY	RESPONSIBLE PARTY
5	Plans for exclusion of cattle and/or other livestock from the reservoir sites	Some owners of the land where reservoirs will be built have livestock. Currently, farmers carry water to the troughs of the animals, and but farmers might wish to use the reservoirs instead, as permanent sources of water for livestock. This is a significant concern because (1) the reservoirs are intended for irrigation of crops, not as a source drinking water for livestock; (2) cattle can trample the sides of the reservoirs, causing destabilization and erosion of the soil banks; and (3) cattle can contaminate the water with urine and feces and fecal-borne pathogenic microorganisms.	Install a fence at each reservoir to exclude livestock Redirect a portion of the water from each reservoir to a separate trough for livestock to use	Visual verification and digital photos documenting that a fence is installed and that the fencing is in good repair and adequate to exclude livestock Visual verification and digital photos documenting that an alternate water source is provided for livestock (The alternate water source could be fed either by the reservoir or by some other water source) Frequency: Every six months (twice annually)	Global Communities/Agrolibano/CIAT
6	Wildlife management at the reservoirs to avoid unintended impacts on wildlife, especially unsustainable hunting of wildlife	Some of the farmers indicated that they hunt animals like the paca (tepezcuintle), rabbits, agouti (guatusa), etc. The reservoirs could become strategic places to hunt these animals because the animals might be attracted to the reservoirs for water, especially in times of extreme heat and drought	Technical assistance for techniques and best practices for wildlife conservation and management	1. Report to USAID/GDL BEO the specific techniques taught to farmers to conserve and manage wildlife Frequency: Before trainings commence 2. Number of beneficiaries trained in wildlife management Frequency: Every six months (twice annually) 3. Surveys of local farmers at each reservoir site to assess hunting intensity and species hunted Frequency: During construction of each dam and every six months (twice annually) thereafter	Global Communities/Agrolibano/CIAT

NO.	CONCERN	ISSUE	MITIGATION MEASURE	INDICATOR & FREQUENCY	RESPONSIBLE PARTY
7	Potential conflict between beneficiaries and non-beneficiaries	The number of beneficiaries will depend on the amount of water collected annually. Community members consulted stated that anyone who is not part of the group can benefit from drip irrigation. People are willing to share the water, but it depends on the amount captured annually to make projections of useable irrigated areas. This is a significant concern because groups currently do not have policies, procedures, or agreements in place to manage potential demand for water.	Provide capacity building and conflict resolution training to producer groups for planning related to water use and sharing water with other community members Design and manage a system to provide for "tail–end users" (those farthest from the water source)	Number of groups Global Communities works with to develop procedures for sharing water among the producer associations and other farmers (report to USAID/GDL BEO the procedures developed and agreed to) Frequency: Every six months (twice annually)	Global Communities/Agrolibano/CIAT
8	Diversion and withdrawal of water to fill and maintain reservoirs and drip irrigation schemes could impact other water users downstream of the reservoir sites	If the reservoirs impact downstream users, this could cause social conflict with other water users	Identify relevant communities downstream of the reservoir sites to determine their water use and potential conflicts	Inspection and interviews with relevant communities related to water access and the existence of any water conflicts Frequency: Every six months (twice annually)	Global Communities/Agrolibano/CIAT
9	Potential negative impacts on threatened and endangered species	Because specific data on the abundance and distribution of threatened and endangered species are not available for the project area, the potential significance of this concern is unknown	Mitigation measures may include those previously mentioned: maintaining adequate environmental flows, pursuing reforestation of the micro-watersheds, and providing training on wildlife management to the surrounding communities	Refer to indicators for concern numbers 1, 3, 5, and 6	Global Communities/Agrolibano/CIAT
10	Irrigation system operation and management	With high sediment loads in the streams, the ultra-low drip irrigation equipment could easily become clogged	Provide both technical support via field visits and training on proper maintenance and trouble-shooting to maintain irrigation equipment	Number of beneficiaries trained in operation and maintenance of ultra-low drip irrigation systems Frequency: Every six months (twice annually)	Global Communities/Agrolibano/CIAT

NO.	CONCERN	ISSUE	MITIGATION MEASURE	INDICATOR & FREQUENCY	RESPONSIBLE PARTY
		At the end of its useful life, irrigation hoses and equipment will need to be disposed of properly	Require the provider of the ultra-low drip irrigation equipment to collect and dispose of it properly.	Inspection of ultra-low drip irrigation equipment for malfunctions Frequency: Every six months (twice annually) Provide visual/graphic info-posters for use in each community on trouble-shooting irrigation systems Frequency: Annually Agreements with providers of ultra-low drip irrigation equipment to properly dispose of the equipment at the end of its useful life Frequency: At project inception and reviewed annually	
11	Agricultural inputs and use	It is unclear in the project plans if an associated activity may include use of agricultural inputs, such as pesticides and fertilizers	If pesticides are contemplated for the agricultural intervention, producers must be trained in proper selection, use and disposal of pesticides and must comply with the current governing USAID/Honduras PERSUAP.	Number of beneficiaries trained in proper selection, use, and disposal of pesticides and fertilizers Frequency: Every six months (twice annually)	Global Communities/Agrolibano/CIAT

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ANNEXES

Annex A: Abridged Scoping Statement

Annex B: Bio-sketches of EA Team

Annex C: List of Contacts

Annex D: Maps

Annex E: Rainwater Harvesting Design (Attached separately)

Annex F: EA Gaps

ANNEX A: SCOPING STATEMENT EXECUTIVE SUMMARY

This Scoping Statement was prepared as part of an Environmental Assessment (EA) process for *Cosecha*: A Rainwater Harvest Project in Southern Region of Honduras (*Cosecha*). The intent of *Cosecha* is to evaluate potential rainwater harvesting for storing water and its impact on agricultural production and nutrition. The project will evaluate effectiveness of rainwater harvesting technology at 10 candidate sites (Table 1). If the project provides compelling evidence that the rainwater harvest and drip irrigation systems help the target population of Honduran farmers achieve higher agricultural productivity, then the design approach and technology used at the 10 sites could provide information on best practices for design of rainwater harvesting projects within the country and region.

The project is an activity of Global Communities (GC), the Honduras Ministry of Agriculture (MoA), the International Center for Tropical Agriculture (CIAT), and two Honduran partners, with partial funding from the USAID Global Development Lab (USAID/GDL). The Scoping Statement was prepared to comply with the Environmental Procedures of the U.S. Agency for International Development (USAID).

The Scoping Statement identifies the potentially significant impacts to be evaluated further in the EA and provides justification for eliminating non-significant impacts from the scope of the EA. The Government of Honduras has plans to develop rainwater harvesting technology to be scaled-up and implemented country-wide separate from this project. It is important to note that the analysis is limited to the 10 candidate sites of the Proposed Action. While the impacts likely to be associated with scaling-up are indicative of what may be identified as issues with rainwater harvesting in general, the sites reviewed are not necessarily representative of conditions country-wide. The Scoping Statement describes the methodology for conducting the EA, including the expertise required and the timeline.

Table 16. Ten Candidate Sites Evaluated in the Scoping Statement

DEPARTMENT	MUNICIPALITY	COMMUNITY
Choluteca	Namasigue	La Constancia
Choluteca	Namasigue	San Rafael 2
Choluteca	Namasigue	Las Pilitas 2
Choluteca	Namasigue	Vuelta del Cerro 2
Choluteca	El Triunfo	Altos de Doña Julia
Choluteca	Namasigue	Santa Irene 1
Valle	Nacaome	Altos El Estiquirin 2
Valle	Nacaome	El Tamarindo 2
Valle	Nacaome	Chaguite
Choluteca	Apacilagua	El Tamarindo 3[1]

[1] The scoping team was unable to visit El Tamarindo 3 as the landowner decided against participating in the project while the team was in Honduras.

Each of the proposed sites will use communal reservoirs linked to gravity-fed, ultra-low drip irrigation systems in combination with improved agronomic practices and technical assistance to grow both subsistence and higher-value horticultural crops. In addition to the sites listed above, the Scoping Team visited one example site with a reservoir, Moracito in Nacaome, Valle, a Global Communities pilot project. The Scoping Team observed the infrastructure required for rainwater harvesting and interviewed the project beneficiaries regarding the operation, management, and early benefits of the project. The beneficiaries indicated the water provided by the reservoir allowed them to cultivate watermelon as a cash crop, whereas previously, they were only able to cultivate subsistence crops, such as rice and beans.

The Scoping Team identified the following aspects of the project with potential significant adverse impacts (discussed in detail in Section 6) to be evaluated in the EA:

1. Maintenance of environmental water flow in the stream channels below the reservoirs;
2. Factors related to construction and design of the reservoirs for long-term sustainability, including: assessment of soil type; patterns of precipitation, including long-term patterns influenced by climate change; water volume; slope; evapotranspiration potential, specifically the surface-area-to-volume ratio; and the condition of the watershed;
3. Plans for management of cattle and/or other livestock near the reservoir sites, including exclusion of livestock and provision of other water sources for the livestock;
4. Technical assistance for the following:
    a. Planning and implementation of reforestation in the reservoir watersheds (including cultivating saplings, species selection, planting, maintenance, etc.);
    b. Managing tilapia in the reservoirs where project implementers introduce tilapia to control mosquitos;
5. Community outreach and training to reduce and mitigate unintended and unsustainable impacts on wildlife, including unsustainable levels of hunting, because wildlife might be attracted to the reservoirs as a water source;
6. Micro-watershed management for long-term sustainability of the water source and reservoir; and
7. Community management of the reservoirs, especially adding new beneficiaries to the producer groups.

From stakeholder consultations, field visits, and document reviews, the Scoping Team identified eight additional concerns (listed below) that can be eliminated from detailed study in the EA. Section 6 discusses these concerns and provides justification for eliminating them:

1. Construction-related noise impacts;
2. Impacts on air quality;
3. Loss of habitat for native plants and animals within the area that will be inundated at each reservoir site;
4. Contamination of the reservoirs by agro-chemicals;
5. Impacts on vegetation within the area that will be inundated at each reservoir site;
6. Impacts related to poor management of solid and liquid waste and excrements;
7. Closing and abandonment of the project;
8. Construction-related access to reservoir sites.

The Scoping Team proposes the following expertise for inclusion on the EA Team; in some cases one team member may possess more than one of the skills below:

- Environmental Impact assessment specialist
- Hydrological/irrigation management specialist
- Climate change specialist
- Agro-forestry expert

The EA for the *Cosecha* project will follow the format required by the U.S. Agency for International Development in 22 CFR 216.6. The project has already received approval from the MoA and other relevant agencies. Thus, the purpose of this Scoping Statement is to fulfill the environmental compliance requirements of 22 CFR 216.

ANNEX B: BIO-SKETCHES OF EA TEAM

CORE (IN-COUNTRY) TEAM

[redacted] (Team Leader/Ecologist/Economist). [redacted] (The Cadmus Group, Inc.) is an Environmental and Social Impact Assessment expert and expert on USAID environmental compliance requirements, including FAA Sections 118 and 119, most recently demonstrated through his contributions to assessments in Senegal, Mali, Peru and South Sudan and his management of a tropical forestry/biodiversity and climate change vulnerability assessment for 10 Caribbean countries. He has leveraged his background in ecology and economics to conduct environmental impact assessments for development projects in Asia and Africa, and to support environmental compliance trainings in Latin America and Africa. He established the procedures for USAID's quick-turn around and in-depth oversight of Multilateral Development Bank projects and has supported several USAID Affirmative Investigations. He has managed extensive policy and finance research and analysis, and facilitated expert consultations in the design of U.S. policy for mitigating the financial risks associated with environmental liabilities (i.e., polluter pays principle/financial assurance). [redacted] has a B.S. in Ecology from the University of Minnesota and a M.A. in International Relations and Environmental Policy from Boston University.

[redacted] (Agricultural Specialist). [redacted] is Sun Mountain's Senior Agriculture, Agroforestry and Climate Change specialist. Mrs. Rodríguez is forestry engineer who holds a master's degree in Tropical Agroforestry from the Agronomic Research and Teaching Center (CATIE) in Costa Rica. She has more than 15 years of experience in the implementation of climate change adaptation and mitigation projects, as well as an intimate familiarity in ecosystem services and water harvesting projects in Central America and Ecuador. She has worked for IUCN, ACICAFOC, CATIE, and many other reputable organizations. [redacted] has extensive experience in Honduras, Guatemala, Costa Rica and Nicaragua. She also has vast experience in environmental assessment, technology transfer, forest management, and in strengthening capacities in climate change adaptation for local authorities and other key stakeholders. In addition, through her work experience, [redacted] has developed influential contacts and the ability to coordinate with local governments and public institutions to generate strategic alliances that increase projects' impact in the territory. With Sun Mountain, [redacted] has been a key team member of the Guatemala Scoping Statement and Environmental Assessment and Honduras Scoping Statement.

[redacted] (Social Specialist). [redacted] holds several fourth degree diplomas in Honduras 1) Social Management, 2) Management of Development Projects, 3) Design and Management of Development Projects and Applied Research, and 4) Education on Human Rights and Democracy. He has been head of various offices in organizations such as World Vision and CARE in Honduras and has managed several development projects with NGOs and public institutions in Honduras. He has over 20 years of experience in organizational and capacity building on: community forestry development and management; profitable farming under forestry systems; community leadership and network strengthening; environmental audits for social development projects; food security in drought vulnerable communities; limit, protection and declaratory of water production areas to community water administration organizations; and community risk prevention, management and response for contingencies. He has worked with Tolupanes and Lenca indigenous groups in Yoro, Lempira and Intibuca. [redacted] also has eight years of experience working with forestry, watershed and risk management in Honduras.

ADVISORY AND HOME SUPPORT TEAM

[redacted] (Research & Analysis and Home Office Support). [redacted] (The Cadmus Group, Inc.) is an environmental policy specialist with development and climate change expertise. She has varied regional experience, conducting a study on service delivery for BRAC Bank in Dhaka, Bangladesh and a semester of studying in Havana, Cuba. Bridgett wrote the energy-efficient building policy for Bowdoin College and wrote small scale energy contracts in Maine. She organized campaigns on divestment from fossil fuels, renewable energy, and safe chemical policy. [redacted] has a BA (triple major) in Government, Environmental Studies, and Spanish Literature from Bowdoin College with an Honors Thesis on the politics and social impacts of South Africa's and Mexico's Carbon Taxes.

[redacted] (GIS Specialist). [redacted] is a GIS specialist with 5 years of experience using geographic information systems in environmental science applications, including climate change assessments, land use change studies, demographic modeling, and hydrographic analyses. [redacted] is responsible for developing and implementing technically demanding large-scale data processing and visualization workflows. He supplements ArcGIS with the Python programming language to automate complex GIS tasks in custom GIS tools. In previous work for USAID, he modified AERMOD—an EPA air modeling software suite—to function in Kosovo by drastically modifying input data. He also created a geoprocessing tool that visualized the outputs of over 500 air quality modeling runs in a consistent and understandable format. In a 118/119 Assessment for Vietnam, [redacted] prepared a series of maps describing the ecology, physiography, climate, and demographics of Vietnam. By client request, the source GIS datasets used were all publicly available to enable reproducibility and many were global-scale to enable inter-comparison. As part of an ongoing project for the US Army Corps of Engineers, [redacted] has worked extensively in calculating, aggregating, and visualizing indicators of climate change vulnerability on a watershed scale. In this role, he used GCM outputs to calculate a variety of hydrological indicators of vulnerability on watershed scale and developed geoprocessing tools that allow for rapid mapping and visualization of climate change vulnerability. [redacted] has a B.S. in Environmental Science from Brown University, where he conducted honors research on remote sensing of agricultural intensification later published in Philosophical Transactions of the Royal Society B: Biological Sciences.

[redacted] (Quality Assurance/Quality Control). [redacted] (The Cadmus Group, Inc.) is an environmental specialist with a background in international development and seven years of experience supporting federal environmental policy development and implementation. [redacted] has contributed to recent FAA Sections 118 and 199 assessments for South Sudan and Barbados and the Eastern Caribbean, and Environmental Threats and Opportunities Assessments (ETOAs) in Mali and Senegal. She has utilized her experience in environmental impact assessment and social issues in the development of Affirmative Investigations for large hydropower projects including Inga 3-BC (DRC), Luhri (India), and a series of run-of-the-river dams in Nepal. [redacted] has a B.A. in Environmental Studies (emphasis on International Development) from Allegheny College, where she conducted a senior thesis on developing an international carbon offset program and engaging stakeholders in the program through a religious focusing point.

ANNEX C: LIST OF CONTACTS

NO.	NAME	ORGANIZATION	TITLE	EMAIL ADDRESS/PHONE
1	[redacted]	Global Communities	National Director	[redacted]
2	[redacted]	Global Communities	Program Manager	[redacted]
3	[redacted]	Global Communities	Operations Manager	[redacted]
4	[redacted]	Independent	Consultant	[redacted]
5	[redacted]	Mi Ambiente	Climate change and rainwater harvesting	[redacted]
6	[redacted]	Mi Ambiente	Assistant Director of Hydrological Resources	
7	[redacted]	Mi Ambiente	Environmental	
8	Peter Hearne	USAID	Mission Environmental Officer	phearne@usaid.gov
9	Issac Ferrera	USAID	Climate Change Office	iferrera@usaid.gov
10	[redacted]	Instituto de Ciencias de la Tierra, UNAH	Professor & Meteorologist	[redacted]
11	[redacted]	Comite Permanente de Contingencias	Meteorologist	
12	---	Instituto de Conservacion Forestal	Departamento de Cuencas Hidrograficas	www.icf.gob.hn/

ANNEX D: EA GAPS

The following gaps exist in the EA analysis:

1. Budget constraints prevented a more in-depth and extensive field visit; thus, the team did not visit the tenth reservoir site and could not provide a detailed description of the site equivalent to other site descriptions.

2. Hydrologic models of the streams and watersheds where the proposed action would occur were not available. If the technology is disseminated more broadly, spatially-based hydrologic analyses should be carried out to understand flow regimes, water balance, and the individual and collective impact of water storage at various levels – stream, watershed, and regional.

3. Stream characteristics: Given the limited field component for the Scoping Statement and EA, the team was not able to measure stream width, depth, riparian zones, sediment size, and other characteristics as part of the baseline data collection.

4. Threatened and endangered species: Additional information on population dynamics and presence of threatened and endangered species was not identified. Information for sensitive species and habitats is coarse and, thus, a conservative approach is recommended to avoid potentially impacting these species further.

5. The Team was not able to hold interviews and meetings with other water user associations, government officials, water users, or other stakeholder groups to solicit information on the broader social context of the project.

ANNEX E: RAINWATER HARVESTING DESIGN

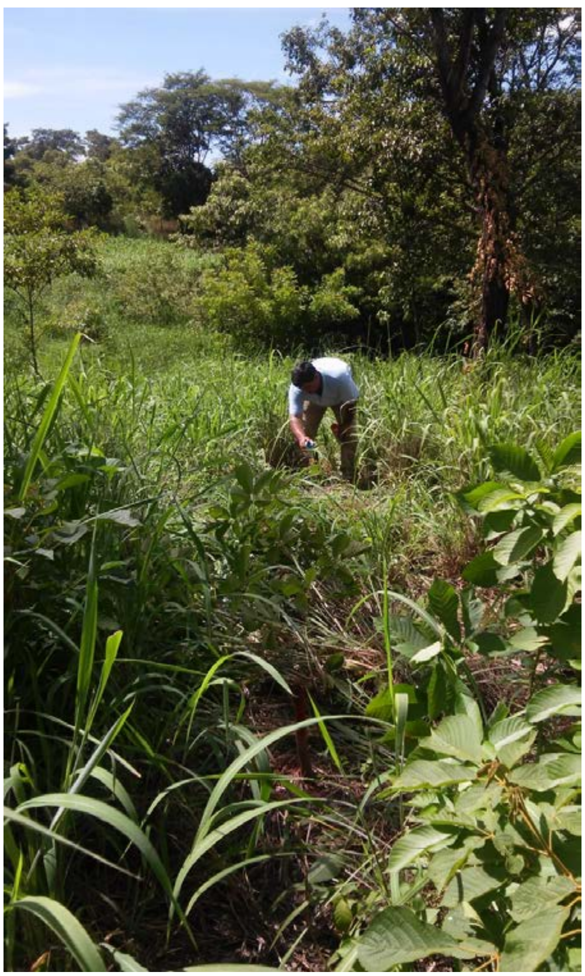
Attached in a separate PDF file.

ANNEX F: PHOTOS OF PROPOSED RESERVOIR SITES

The following photos are included to provide context for the site description for the site in Section 3.1.3.Photos of Vuelta del Cerro 2 were added to this Annex as the site was not visited by the Scoping Team in August 2015. The photos were provided by Global Communities in November 2015.

Location: Vuelta del Cerro 2, Namasigue, Choluteca

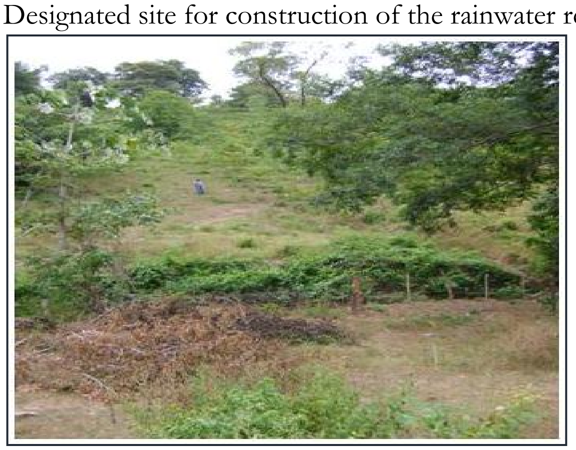
Photos depict the proposed reservoir site and existing vegetation.

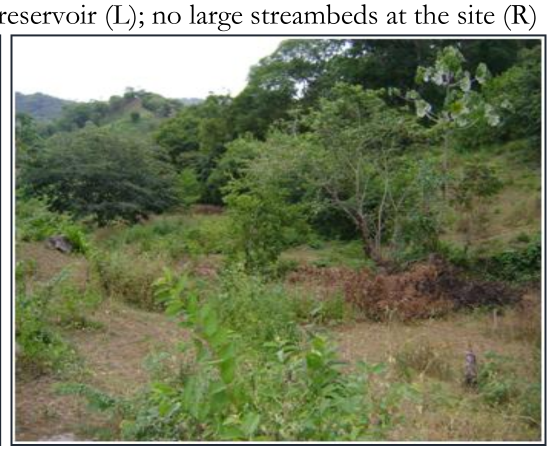


Location: El Moracito Arriba, Jicaro Galan
Date: 15 August 2015
Pilot project of Global Communities and Grupo Nuevo amanecer in Nacaome, Valle (L) and watermelon fields (R)

Location: La Constancia, 12 de noviembre
Date: 15 August 2015
Designated area for construction of the rainwater reservoir in Choluteca, Namasigue (L); dry creek bed; water flows during winter.

Location: San Rafael 2, Choluteca, Namasigue
Date: 15 August 2015
Designated site for construction of the rainwater reservoir (L); no large streambeds at the site (R)





Location: Pilitas 2, San Francisco Community, Choluteca, Namasigue
Date: 15 August 2015
The reservoir was built five years ago (L) and the new reservoir will be expanded uphill of the existing site (R)

Location: Vuelta al Cerro 1, October 24 Association, Namasigue, Choluteca
Date: 16 August 2015
Selected area for the construction of the reservoir (L); livestock grazing at the project site (R)

Location: Altos de Doña Julia, Choluteca, El Triunfo
Date: 17 August 2015
Selected site for reservoir construction (L); site is currently used for agriculture and subject to slash and burn (R)


Location: Santa Irene 1, Choluteca, Namasigue
Date: 17 August 2015
Selected area for the construction of the reservoir, recently burned to cultivate crops (L, R); the school is 50 meters downstream from the dam site.


Location: Altos de Estiquirín 2, Valle, Nacaome
Date: 18 August 2015
Selected site for construction of the reservoir (L). The creek bed and overall site is very rocky, which will need to be removed for reservoir construction (R)


Location: Tamarindo 2, Nacaome, Valle
Date: 18 August 2015
Selected site for the construction of the reservoir (L) Hillsides in the micro-watershed have minimal forest cover (R)


Location: Chaguite, Nacaome, Valle
Date: 18 August 2015
A small pond was created for extraction of clay on the site, which is where the reservoir will be located (L); minnows found in the ephemeral pond (R); cattle graze in the area surrounding the existing pond (Lower)